









QE  
756  
I4A3

MEMOIRS  
OF THE  
GEOLOGICAL SURVEY OF INDIA.

*Palæontologia Indica,*

BEING  
FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING  
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. X.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

Vol. IV.

Part I. SIWALIK MAMMALIA — SUPPLEMENT I.

By R. LYDEKKER, B.A., F.G.S., etc.

WITH 6 PLATES.

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE, AND BY ALL BOOKSELLERS.

LONDON: TRÜBNER & CO.

MDCCCLXXXVI.

PRINTED BY GIBBS AND BAMFORTH, ST. ALBANS, HERTS.



10

QE 756  
I4A3

**Palæontologia Indica.**

**SERIES X.**

**VOL. IV.**





Footnote, Robert Bruce

MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.

141  
159  
Pat 2

*Palæontologia Indica,*

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE  
PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR-GENERAL OF INDIA IN COUNCIL.

SERIES X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

VOL. IV.

PART 1.—SIWALIK MAMMALIA—SUPPLEMENT 1.

By R. LYDEKKER, B.A., F.G.S., ETC.

PART 2.—THE FAUNA OF THE KARNUL CAVES

(and addendum to Part 1).

By R. LYDEKKER, B.A., F.G.S., ETC.

PART 3.—EOCENE CHELONIA FROM THE SALT-RANGE.

By R. LYDEKKER, B.A., F.G.S., ETC.

CALCUTTA :

SOLD AT THE

GEOLOGICAL SURVEY OFFICE.

LONDON : KEGAN PAUL, TRENCH, TRUBNER & CO.

MDCCCII.

QE756  
I4

CALCUTTA:  
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,  
8, HASTINGS STREET.



# CONTENTS.

## PART I.

### SIWALIK MAMMALIA—(SUPPLEMENT I).

	PAGE.
INTRODUCTORY . . . . .	1
The Primates . . . . .	"
Family Simiidae . . . . .	"
Trogodytes sivalensis . . . . .	"
Simia, sp. . . . .	4
Family Cercopithecidae . . . . .	"
Semnopithecus palæindicus . . . . .	5
Macacus sivalensis . . . . .	"
Cynocephalus sub-himalayanus . . . . .	6
" falconeri . . . . .	7
The Antelopes . . . . .	"
Oreas (?) latidens . . . . .	8
Strepsiceros (?) falconeri . . . . .	"
Boselaphus, sp. . . . .	9
Palæoryx . . . . .	10
Hippotragus sivalensis . . . . .	11
Gazella porrecticornis . . . . .	"
" sp. . . . .	12
Cobus (?) palæidicus . . . . .	"
" patulicornis . . . . .	14
Genus non. det. . . . .	"
Alcelaphus palæindicus . . . . .	"
The Genus Merycopotamus . . . . .	16
Merycopotamus dissimilis . . . . .	"
" nanus . . . . .	17
" pusillus . . . . .	18
Addendum with part II . . . . .	"
Genus, Tetracerus, Leach . . . . .	19
" Daviesi, n. sp. nobis . . . . .	"
Postscript . . . . .	22

## PART II.

### THE FAUNA OF THE KARNUL CAVES.

INTRODUCTORY OBSERVATIONS . . . . .	23
Mammalia . . . . .	26
Semnopithecus entellus . . . . .	28
Cynocephalus, sp. . . . .	"
Felis tigris (or ? leo) . . . . .	29
pardus . . . . .	"
Chaus . . . . .	"
rubiginosa . . . . .	30
Hyæna crocuta . . . . .	"
Viverra karnuliensis . . . . .	31
Prionodon, sp. . . . .	32
Herpestes griseus . . . . .	"
fuscus . . . . .	33
Ursus labiatus . . . . .	"
Sorex, sp. . . . .	"
Taphozous saccolæmus . . . . .	34
Phyllorhina diadema . . . . .	"
Sciurus macrurus . . . . .	"
Gerbillus indicus . . . . .	"

	PAGE.
<i>Nesokia bandicoota</i> . . . . .	35
<i>kok</i> . . . . .	"
<i>Mus mettada</i> . . . . .	36
<i>platythrix</i> . . . . .	"
<i>sp.</i> . . . .	"
<i>Golunda ellioti</i> . . . . .	"
<i>Hystrix crassidens</i> . . . . .	37
<i>Atherura karnuliensis</i> . . . . .	38
<i>Lepus (cf. nigricollis)</i> . . . . .	"
<i>Equus asinus</i> . . . . .	39
<i>sp. a</i> . . . . .	"
<i>Rhinoceros karnuliensis</i> . . . . .	40
<i>Bos, or Bubalus, sp.</i> . . . .	44
<i>Boselaphus tragocamelus</i> . . . . .	"
Genus, <i>non. det.</i> . . . .	45
<i>Gazella bennetti</i> . . . . .	"
<i>Antilope cervicapra</i> . . . . .	"
<i>Treraceros quadricornis</i> . . . . .	46
<i>Cervus aristotelis</i> . . . . .	"
<i>axis</i> . . . . .	"
<i>Cervulus muntjac</i> . . . . .	47
<i>Tragulus (cf. meminna)</i> . . . . .	"
<i>Sus cristatus</i> . . . . .	"
<i>karnuliensis</i> . . . . .	49
<i>Manis gigantea</i> . . . . .	50
Aves . . . . .	51
<i>Neophron percnopterus</i> . . . . .	"
? <i>Milvus, or Circus, sp.</i> . . . .	"
<i>Ketupa ceylonensis</i> . . . . .	52
<i>Bubo coromandus</i> . . . . .	"
<i>Francolinus pictus</i> . . . . .	"
<i>pondicerianus</i> . . . . .	53
<i>Grus (cf. communis)</i> . . . . .	"
<i>Ibis melanocephala</i> . . . . .	"
Reptilia . . . . .	54
<i>Crocodylus, sp.</i> . . . .	"
<i>Varanus dracæna</i> . . . . .	"
<i>Python molurus</i> . . . . .	55
<i>Naia tripudians</i> . . . . .	56
<i>Ptyas mucosus</i> . . . . .	"
Amphibia . . . . .	"
<i>Bufo melanostictus</i> . . . . .	"
Mollusca . . . . .	57
Addendum . . . . .	"
<i>Herpestes nipalensis</i> . . . . .	"
List of the Fauna . . . . .	58

## PART III.

## EOCENE CHELONIA FROM THE SALT-RANGE.

INTRODUCTORY . . . . .	59
Pleurodira . . . . .	61
Family Carettochelydidae . . . . .	"
Genus <i>Hemichelys, nobis. 6</i> . . . . .	"
" <i>warthi, nobis. 1</i> . . . . .	62
Family Chelydidae . . . . .	63
Genus <i>Podocnemis, Wagler 6</i> . . . . .	"
" <i>Indica, n. sp. nobis</i> . . . . .	"



MEMOIRS  
OF THE  
GEOLOGICAL SURVEY OF INDIA.

---

*Palæontologia Indica,*

BEING  
FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING  
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

---

Ser. X.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

Vol. IV.

Part I. SIWALIK MAMMALIA — SUPPLEMENT I.

By R. LYDEKKER, B.A., F.G.S., etc.

WITH 6 PLATES.

---

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE, AND BY ALL BOOKSELLERS.

LONDON: TRÜBNER & CO.

---

MDCCCLXXXVI.

---

PRINTED BY GIBBS AND BAMFORTH, ST. ALBANS, HERTS.



QE756

±4A3

CONTENTS.

	PAGE		PAGE
Introductory . . . . .	1	Boselaphus, sp. . . . .	9
The Primates . . . . .	„	Palæoryx . . . . .	10
Family Simiidæ . . . . .	„	Hippotragus sivalensis. . . . .	11
Trogodytes sivalensis . . . . .	„	Gazella porrecticornis . . . . .	„
Simia, sp. . . . .	4	„ sp. . . . .	12
Family Cercopithecidæ . . . . .	„	Cobus (?) palæindicus . . . . .	„
Semnopithecus palæindicus . . . . .	5	„ patulicornis . . . . .	14
Macacus sivalensis . . . . .	„	Genus non. det. . . . .	„
Cynocephalus subhimalayanus . . . . .	6	Alcelaphus palæindicus . . . . .	„
„ falconeri . . . . .	7	The Genus Merycopotamus . . . . .	16
The Antelopes . . . . .	„	Merycopotamus dissimilis. . . . .	„
Oreas (?) latidens . . . . .	8	„ nanus . . . . .	17
Strepsiceros (?) falconeri . . . . .	„	„ pusillus . . . . .	18



# INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

---

## SIWALIK MAMMALIA—SUPPLEMENT I.

By R. LYDEKKER, B.A., F.G.S., ETC.

(WITH PLATES I. TO VI.)

---

### INTRODUCTORY.

The present memoir contains descriptions and figures of the remains of three groups of Siwalik Mammals, which have either not been fully treated of in the preceding volumes of this work, or in which new species have been founded since such descriptions were written.

The three groups here treated of comprise the Primates, the Antelopes, and the genus *Merycopotamus*. The first two groups are of especial interest in regard to distributional zoology on account of their containing a large number of forms either definitely or provisionally referred to genera now characteristic of the Ethiopian region,<sup>1</sup> which have not been hitherto found in the tertiaries of Europe. In the case of some of the fossil antelopes where the generic reference is provisional it is quite clear that these species have no affinity to the numerically small antelopine fauna of modern India, and if they be not really generically identical with the Ethiopian forms with which they are grouped, they are evidently very closely allied, and probably indicate the source whence such genera took their origin. In other instances, however, there can be no doubt as to the generic identity of the Siwalik and Ethiopian forms.<sup>2</sup> It may be observed that since the Pikermi beds have yielded certain antelopes (*Palæoreas* and *Protragelaphus*) allied to existing Ethiopian forms, it may be inferred that the ancestors of a considerable part of the existing Ethiopian fauna ranged over a large area of the Euro-Asiatic continent, but as none of the Pikermi antelopes (excepting the widely distributed *Gazella*) have

<sup>1</sup> Some of the existing baboons and antelopes of the Ethiopian also enter the adjacent parts of the Palearctic region.

<sup>2</sup> In regard to the migration of Pliocene Siwalik genera into Africa see 'Quart. Journ. Geol. Soc.' vol. XLII. p. 175 (1886).



## 2 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

been generically identified with existing African forms, while *Troglodytes*, *Cynocephalus* and *Struthio* are unknown from those deposits, the affinity of the fauna of Africa to that of the Pikermi beds does not appear to be so close as it does to that of the Siwaliks. The genus *Merycopotamus* needs no introductory comment.

### I. THE PRIMATES.

#### FAMILY I. *SIMIIDÆ*.

##### GENUS I. *TROGLODYTES*, E. Geoffroy.<sup>1</sup>

*Dentition*.—The upper dentition of the existing representative of this genus is characterized by the small size of m. 3 and the relative shortness of the antero-posterior diameter of the upper premolars, in both of which respects it differs markedly from *Gorilla* and *Simia* and approximates to man. The Siwalik representative was formerly referred to a distinct genus under the name of *Palæopithecus*.<sup>2</sup>

Species. *TROGLODYTES SIVALENSIS*, *nobis*.<sup>3</sup>

Syn. *Palæopithecus sivalensis*, *nobis*.<sup>4</sup>

*History*.—The palate on which this species is founded was collected in 1878 by Mr. Theobald near Jabi in the Punjab, and has been already described and figured in the paper cited.

*Palate*.—The type palate is represented in pl. I. figs. 1, 1a; on the right side the canine and the last four cheek-teeth are preserved, while pm. 3 and the outer incisor are shown by their broken bases: the summit of the canine and the postero-external angle of m. 2 have been broken off, and the centre of the crown of the latter has been affected by decay during the life of the animal. On the left side m. 2 is in a perfect condition, but the crowns of m. 1 and m. 3 are broken off. All the teeth are partially worn. It was originally considered that the specimen belonged to a female, but a comparison with skulls of the Chimpanzee (in which the canine is relatively smaller than in the Orang and Gorilla) indicates that it should rather be referred to a male.<sup>5</sup>

That the affinity of the specimen is with the larger *Simiidae* is self-apparent. The two series of cheek-teeth have a slight convergence anteriorly, in which respect they differ from *Gorilla*, *Simia*, and *Troglodytes niger* (in which the inclination is in the opposite direction), and agree with *Hylobates*. The outer border of the premolars is placed somewhat internally to that of the true molars, while the corresponding border of m. 2 is placed externally to that of m. 1 and m. 3, in both of which features the specimen differs from *Gorilla*<sup>7</sup> and *Simia*<sup>8</sup> and agrees with *Troglodytes niger*,<sup>9</sup> although in the excessive development of these features it is still closer

<sup>1</sup> 'Ann du Muséum.' vol. XIX. p. 87 (1812).

<sup>2</sup> 'Rec. Geol. Surv. Ind.' vol. XII. p. 33 (1879). The writer then followed Owen's arrangement of including *Gorilla* in *Troglodytes*.

<sup>3</sup> 'Rec. Geol. Surv. Ind.' vol. XII. p. 33 (1879).—*Palæopithecus*.

<sup>4</sup> *Loc. cit.*

<sup>5</sup> In the original figure (plate facing p. 52 fig. 5) the two fragments of the specimen were not put in apposition.

<sup>6</sup> In the small size of its canine the male Chimpanzee resembles the female Orang.

<sup>7</sup> Compare Owen 'Trans. Zool. Soc.' vol. IV. pl. XXVI.

<sup>8</sup> *Ibid.* pl. CLXV.

<sup>9</sup> Owen "Odontography" pl. CXVIII. fig. 1.

to *Hylobates*.<sup>1</sup> The true molars differ from those of *Simia* by the simple structure of the cusps and the absence of the rugosities on the crown surface, as well as by the small size of *m. 3*; and are also widely different from those of *Gorilla* in which *m. 3* is much larger than either of the other two molars; the premolars are also of very different form from the corresponding teeth of those genera. Compared with *Troglodytes* the fossil agrees in the form of the cusps of the true molars, in the relatively small size of *m. 3* and the slight development of its posterior cusps and the oblique connecting ridge,<sup>2</sup> as well as in the presence of an indistinct cingulum on the internal surfaces of these teeth<sup>3</sup>; the relatively small antero-posterior diameter of the premolars and the larger size of their external as compared with their internal cusps are also features characteristic of *Troglodytes*.<sup>4</sup> In some specimens of *T. niger* the antero-posterior diameter of the premolars is relatively greater than in the fossil but in others<sup>5</sup> it is very nearly the same. The canine agrees precisely with that of the male *T. niger*.<sup>6</sup> The outer (and therefore probably the inner) incisor is relatively narrower than in the latter, and the diastema is thus somewhat larger, but this need not be more than a specific difference. In absolute size the fossil is rather larger than the male *T. niger*<sup>7</sup>; its dimensions in inches being as follows:

Interval between outer borders of second molars . . . . .	2.4
"    "    inner    "    "    "    "    "    "    "    "    "    "	1.5
Antero-posterior diameter of base of outer incisor . . . . .	0.3
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.19
Antero-posterior diameter of canine . . . . .	0.53
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.51
Length of series of cheek-teeth . . . . .	1.87
Antero-posterior diameter of pm. 3 (broken) . . . . .	0.3
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.5
Antero-posterior diameter of pm. 4 . . . . .	0.3
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.35
Antero-posterior diameter of m. 1 . . . . .	0.45
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.51
Antero-posterior diameter of m. 2 . . . . .	0.5
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.51
Antero-posterior diameter of m. 3 . . . . .	0.41
Transverse    "    "    "    "    "    "    "    "    "    "    "	0.46

*Affinities.*—The above comparisons shew that the specimen under consideration indicates an ape generically distinct from both *Gorilla* and *Simia*, but so close to *Troglodytes* as to leave little doubt of its identity—an identity rendered the more probable by the occurrence of *Cynocephalus* in the same region. In those respects in which the Siwalik *Troglodytes* differs from the existing African species it shows in a still more marked degree the approach to the human type of dentition presented by the latter, and serves, in a small degree, to bind still closer the connection between the *Simiidae* and the *Hominidae*. In the inclination of the two

1 The fossil is distinguished from this genus not only by its superior size, but by the relatively narrower premolars.

2 See Owen "Odontography," p. 446.

3 Owen "Anatomy of Vertebrates," vol. II. p. 320.

4 Owen "Odontography," p. 446.

5 Compare Blainville "Ostéographie," Genus *Pithecus*. pl. V.

6 Owen. *op. cit.* p. 445.

7 The length of the three molars of the fossil is 1.31, the corresponding length in a male *T. niger* being 1.2.

#### 4 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

series of cheek-teeth and the relative lateral position of the premolars to the true molars the genus *Hylobates* makes an approach to the human type which is wanting in all the larger existing *Simiidae*, and it is very noteworthy to find a similar relation obtaining in the Siwalik *Troglodytes*, accompanied by a more human-like structure of the upper premolars.<sup>1</sup>

The occurrence of *Troglodytes* and *Simia* in the Siwaliks and the existence of the latter in Borneo and Sumatra indicates that the later ancestral home of the larger existing *Simiidae* was probably in the Oriental region, although in earlier times the family ranged over Southern Europe; and it is a very significant fact from an evolutionary point of view that the Siwalik *Troglodytes* appears to be more specialized than any of its existing allies.

The existence of large apes in the Siwaliks of the Punjab indicates that the physical condition of that region in the pliocene epoch must have been widely different from that obtaining at the present day.

#### GENUS II. SIMIA, Linn.<sup>2</sup>

*Distribution.*—The genus is now confined to Borneo and Sumatra. Remains of the existing species are found in a subfossil condition in the caves of the latter island, but, with the exception of the Siwalik form, no fossil species have been described.

##### SIMIA, sp.

*History.*—The first notice of this form was published in 1837 by Falconer and Cautley,<sup>3</sup> and later notes by Falconer and Prinsep<sup>4</sup> indicated its close affinity to *Simia satyrus*. The present writer<sup>5</sup> when describing the Siwalik *Troglodytes* as *Palæopithecus* regarded the type specimen of the present form as belonging to a male of the Punjab ape.

*Upper canine.*—The one known specimen of this form is a worn left upper canine,<sup>6</sup> which was obtained from the Siwalik Hills, but is now unfortunately lost. It is fully equal in size to the corresponding tooth of a large male *S. satyrus*, the resemblance being stated to be so close that it was impossible to distinguish between the two. There is therefore every probability that the specimen indicates the existence of a Siwalik species of *Simia*.

#### FAMILY II. CERCOPITHECIDÆ.

##### GENUS I. SEMNOPITHECUS, F. Cuvier.<sup>7</sup>

*Distribution.*—The genus is at the present day characteristic of the forest regions of the whole Oriental region; and was represented by *S. monspessulanus*, Gervais, in the lower pliocene of Montpellier (Hérault) and Casino (Tuscany).<sup>8</sup>

<sup>1</sup> The human cranium with the most ape-like palate is the one figured by O. Thomas in the 'Journ. Anthropol. Inst.' vol. XIV. pl. XIV. (1885).

<sup>2</sup> "Syst. Nat." ed. 12. vol. I. p. 34 (1766).

<sup>3</sup> 'Journ. As. Soc. Beng.' vol. VI. p. 359. pl. XVIII. fig. C.

<sup>4</sup> "Palæontological Memoirs," vol. I. pp. 304-307. fig. 11; vol. II. p. 578.

<sup>5</sup> 'Rec. Geol. Surv. Ind.' vol. XII. p. 38 (1879).

<sup>6</sup> "Palæontological Memoirs," vol. I. p. 304. fig. 11.

<sup>7</sup> "Hist. Nat. d. Mammifères" (1821). *Semnopithèque*.

<sup>8</sup> See Major 'Atti. Soc. Tosc. Sci. Nat.' vol. I. p. 224 (1876).

Species. SEMNOPITHECUS PALÆINDICUS, *nobis*.<sup>1</sup>

*History*.—The history of the specimens referred to this species (which were all obtained from the typical Siwalik Hills) is given in the "Cat. Foss. Mamm. Brit. Mus." pt. I. pp. 2, 3.

*Mandible*.—The type specimen is figured in pl. I. fig. 7, and consists of part of the hinder portion of the right ramus of the mandible showing the last four cheek-teeth in a half-worn condition; the right ramus of the mandible of a large male of *S. schistaceus* (Hodgson) being represented in fig. 6. A comparison of these two figures shows such an extremely close resemblance as to indicate that the two specimens are generically identical.<sup>2</sup> The absolute size of the teeth is the same in the recent and fossil jaws, and both exhibit a large hind talon to  $\overline{m. 3}$ .<sup>3</sup> The fossil jaw is, however, readily distinguished from the mandible of *S. schistaceus* and the rather smaller *S. entellus* by the inferior vertical depth of the ramus.<sup>4</sup>

*Other specimens*.—Another fragment of a right mandibular ramus and a right astragalus are provisionally referred to this species in the "Cat. Foss. Mamm. Brit. Mus." pt. I.

*Affinities*.—The specific distinctness of this form from *S. schistaceus* and *S. entellus* indicates that it is equally distinct from all the other existing species, none of which attain the size of the former; the fossil *S. monspessulanus* is also of considerably smaller dimensions. That *S. palæindicus* may have been the ancestor of *S. schistaceus* is highly probable.

## GENUS II. MACACUS, Cuv. and Geoffroy.<sup>5</sup>

*Distribution*.—The genus is now spread over the whole of the Oriental region, and also occurs in north Africa, Gibraltar, Tibet, north China, and Japan. If the generic determination of *M. pliocen*, Owen,<sup>6</sup> be correct the genus occurred in the pleistocene of England, and it was represented in the upper pliocene of the Val d'Arno by *M. florentinus*, Cocchi, and *M. ausonius*, Major,<sup>7</sup> and in the lower pliocene of Montpellier and Casino<sup>8</sup> by *M. priscus*, Gervais.

Species. MACACUS SIVALENSIS, *nobis*.<sup>9</sup>

*History*.—This species is founded on two fragments of maxillæ obtained in 1877 by Mr. Theobald, from the Siwaliks of the Punjab, which have been previously described and figured in the 'Records.'<sup>10</sup>

*Maxilla*.—The two type specimens are represented in pl. I. figs. 9, 10, and the right half of the palate of a male of *M. rhesus* in fig. 8. Fig. 9 is a fragment of

<sup>1</sup> *Supra*. vol. III. p. 123 (1884).

<sup>2</sup> A comparison of these figures with figs. 4, 5, will show the distinctness of the present fossil from *Cynocephalus*.

<sup>3</sup> Some specimens of *S. entellus* show a much smaller talon to this tooth. It is not improbable that the jaw with which Falconer and Cautley compared the fossil may have belonged to *S. schistaceus* rather than to *S. entellus*.

<sup>4</sup> See "Palæontological Memoirs," vol. I. pl. XXIV. fig. 5.

<sup>5</sup> 'Magasin Encyclopédique,' 1795.—*Macaque*.

<sup>6</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. I. p. 4.

<sup>7</sup> 'Atti. Soc. Tosc. Sci. Nat.' vol. I. p. 39 (1876). The writer is unacquainted with a description or figure of the remains of this species or of *M. florentinus*.

<sup>8</sup> See Major, *op. cit.* p. 224.

<sup>9</sup> 'Rec. Geol. Surv. Ind.' vol. XI. p. 70 (1878).

<sup>10</sup> 'Loc. cit.' and vol. XII. plate facing p. 52. figs. 2, 3.

the left maxilla showing the unworn m. 3 and the broken bases of the three preceding teeth, while fig. 10 belongs to the opposite side and exhibits the base of pm. 4, the almost unworn m. 1 and m. 2, and m. 3 in alveolo. The curved line of the molar series (fig. 10) together with the relatively small size of the hinder cusps of m. 3 (fig. 9), and the absolutely small dimensions of the teeth indicate that the fossils belong to *Macacus* rather than *Semnopithecus*, while the small size of m. 1 in comparison to m. 2 forbids their reference to *Cercopithecus*.<sup>1</sup>

*Affinities*.—With regard to the question of species, the fossil jaws are smaller than those of *M. rhesus*, *M. silenus*, *M. radiatus*, and (apparently) *M. sinicus*, while the anterior zygomatic root is placed more anteriorly. The specimens have not been compared with the non-Indian existing species of the genus, from which their specific distinction may be assumed: they are decidedly smaller than the fossil *M. pliocenus* and *M. priscus*, but for the reason already stated the writer has been unable to compare them with the two Italian fossil species.

### GENUS III. CYNOCEPHALUS, Lacépède.<sup>2</sup>

*Distribution*.—This genus is now mainly characteristic of the Ethiopian region, although it also ranges over the whole of Africa, *C. hamadryas* extending from Abyssinia to Arabia. A fossil species is recorded by M. P. Thomas<sup>3</sup> from the upper pliocene of Algeria, and has been provisionally named *C. atlanticus*. In India the genus occurs in the pliocene of the Siwalik Hills, and persisted into the late pleistocene of Madras.<sup>4</sup> It may be added that for palæontological purposes the genus *Theropithecus* must be included in *Cynocephalus*.

Species 1. CYNOCEPHALUS SUBHIMALAYANUS (H. von Meyer<sup>5</sup>).

Syn. *Semnopithecus subhimalayanus*, H. von Meyer.<sup>6</sup>

*History*.—The history of the only known specimen of this species is given in the writer's "Cat. Foss. Brit. Mamm. Mus." pt. I. pp. 4, 5.

*Cranium*.—The type specimen, which was obtained from the Siwalik Hills, is represented in pl. I. figs. 3, 3a; and in order to exhibit more clearly its characteristic features it has been partially restored in outline, and a figure given (fig. 2) of the right half of the palate of a female of the existing *C. babouin* in which the cheek-teeth are unworn. The fossil comprises the greater part of the right half of the facial part of the cranium, showing the root of the zygomatic arch and the inferior border of the orbit (*or.*), and containing the five cheek-teeth in a half-worn condition, and part of the base of the canine. The small size of the canine shows that the specimen belongs to a female, while the contour of the maxilla and the characters of the teeth indicate conclusively its generic position. The general contour is not unlike that of the cranium of *C. babouin*, but the lateral surface of the maxilla is

<sup>1</sup> See 'Rec. Geol. Surv. Ind.' vol. XI. p. 69.

<sup>2</sup> "Nouv. Table Méthod." (1799), in 'Mém. d. l' Institut.' vol. III. p. 490 (1801).

<sup>3</sup> 'Mém. Soc. Géol. France.' ser. 3. vol. III. art. 2. p. 14. pl. X. fig. 4 (1884).

<sup>4</sup> The Madras form will be described in part 2 of this volume.

<sup>5</sup> In Bronn's "Index Palæontologicus," p. 1133 (1848).—*Semnopithecus*.

<sup>6</sup> *Loc. cit.*



convex instead of concave, and the teeth are of very much larger size. In regard to the contour of the maxilla *C. anubis* comes nearer to the fossil. The length of the space occupied by the five cheek-teeth is the same as in a full-sized male of the large *C. porcarius*, but the true molars of the fossil are considerably wider. The writer has been unable to compare the fossil with female skulls of all the existing species of the genus, but judging from the last comparison it would seem probable that the Siwalik form attained a larger size than any existing species; and this, together with the apparent extinction of all the contemporary mammals, indicates that there can be little doubt as to its specific distinctness.

Species 2. *CYNOCEPHALUS FALCONERI*, n. sp. *nobis*.

*History*.—The history of the type and only known specimen of this smaller species is recorded in the "Cat. Foss. Mamm. Brit. Mus." pt. I. p. 6.

*Mandible*.—The type mandible was obtained from the Siwalik Hills, and is represented in pl. I. fig. 4, the right ramus of a mandible of a female of *C. babouin* being represented in fig. 5. The fossil comprises the entire symphysis and the greater portion of the right ramus, and shows the three true molars in a well-worn condition, together with portions of the two premolars; the canine is wanting, but the protuberance of the ramus at the point where this tooth should be, together with the generally elongated form of the jaw, indicates that the specimen probably belonged to a male.

That this mandible belongs to *Cynocephalus* is at once evident from the elongated symphysis, and the flatness of the oral surface of the latter,<sup>1</sup> together with the relatively broad cheek-teeth and the small size of the hind talon of  $\overline{m.3}$ . The length of the space occupied by the three true molars is very much less than in the palate represented in fig. 3, which at once indicates that the present mandible (even if it belong to a female) is specifically distinct from *C. subhimalayanus*.<sup>2</sup> The length of the space occupied by the three true molars is the same as in the female of *C. babouin*, but the length in front of  $\overline{pm.1}$  is much greater.

*Specific distinctness*.—Although it cannot be certainly affirmed that the present form is specifically distinct from all the existing species of the genus, yet the apparent extinction of all the true Siwalik mammals renders it probable that this is the case, and the name of *C. falconeri* is accordingly proposed for it.

## II. THE ANTELOPES.

### GENUS. *OREAS*, Desmarest.<sup>3</sup>

*Distribution*.—The two existing species inhabit all tropical and southern Africa. *Palæoreas* is an allied form occurring in the lower pliocene of Pikermi, in

<sup>1</sup> *Semnopithecus* and its allies (fig. 6) have the symphysis deeply depressed immediately behind the incisors.

<sup>2</sup> In the *Cercopithecidae* the length of the lower molars always exceeds that of the upper; compare figs. 5, 2.

<sup>3</sup> "Mammalogie," p. 471 (1822).

## 8 INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

the upper pliocene of the Val d'Arno<sup>1</sup> and of Algiers,<sup>2</sup> and the pleistocene of France;<sup>3</sup> the species of the latter area being regarded as connecting the older forms with *Tragelaphus*.

Species. OREAS (?) LATIDENS, *nobis*.<sup>4</sup>

Syn. *Cervus latidens*, *nobis*.<sup>5</sup>

*Summary*.—This species is known by the dentition, which is described and figured in vol. III. pp. 111-114. pl. XIII. figs. 12, 13. The upper molars agree very closely with those of *O. canna*, but have a larger internal accessory column;—a circumstance of importance in regard to the teeth of the next species, as it may indicate a character common to the earlier forms. The enamel is smooth, and there is a distinct median costa on the outer surface of the anterior lobes of the upper true molars.

GENUS. STREPSICEROS, Gray.<sup>6</sup>

*Distribution*.—The two existing species range over tropical and southern Africa; the smaller *S. imberbis* being found in Somali-land, which is on the route by which the Siwalik genera may have passed into Southern Africa.<sup>7</sup> The allied *Tragelaphus* is a still smaller form, which is closely related to *Protragelaphus*, Dames,<sup>8</sup> of the Pikermi beds.

Species. STREPSICEROS (?) FALCONERI, *nobis*.<sup>9</sup>

*History*.—This species is founded on an immature cranium in the British Museum,<sup>10</sup> which has not hitherto been figured.

*Cranium*.—The type cranium is represented in plate II. figs. 2, 2a, a cranium of the existing *S. kudu* being represented in figures 1, 1a, of the same plate. The fossil, which was obtained from Perim Island, wants the nasals, the premaxillæ, and part of the maxillæ; the palate is obscured, the teeth partly broken, and only a fragment of the right horn-core remains: the milk-molars are still retained, m. 1 is in use, m. 2 in alveolo,<sup>11</sup> while m. 3 is not seen at all. It agrees with the existing species of *Strepsiceros* and *Oreas*<sup>12</sup> in the depressed frontals, with large supraorbital pits, but differs from the latter by the absence of a protuberance on the lachrymal, in the position of the notch in the rim of the orbit, in the wider interval between the horn-cores, the closer approximation of the latter to the orbits, and their greater distance from the supraoccipital ridge. As will be seen by a comparison of the

<sup>1</sup> F. Major, 'Quart. Journ. Geol. Soc.' vol. XLI. p. 2 (1885).—*P. montis-caroli*.

<sup>2</sup> Thomas, 'Mém. Soc. Géol. Soc. France,' ser. 3. vol. III. art. 2. p. 16 (1884). *P. gaudryi*.

<sup>3</sup> See Deperet, 'Bull. Soc. Géol. France.' 1884. p. 278.—*P. torticornis* (Aym).

<sup>4</sup> *Supra*. vol. I. p. 65 (1876).—*Cervus*.

<sup>5</sup> *Loc. cit.*

<sup>6</sup> List of Mammalia in British Museum. p. 155 (1843).

<sup>7</sup> Lydekker 'Quart. Journ. Geol. Soc.' vol. XLII. p. 175 (1886).

<sup>8</sup> Sitz. Ges. nat. Berlin. 1883. pp. 95-97.

<sup>9</sup> 'Geol. Mag.' dec. 3. vol. II. p. 170 (1885).

<sup>10</sup> See 'Cat. Foss. Mamm. Brit. Mus.' pt. II. p. 47. No. 37262 (1885).

<sup>11</sup> In the 'Cat. Foss. Mamm. Brit. Mus.' *loc. cit.* this tooth was mistaken for m. 3.

<sup>12</sup> A figure of the cranium is given by Rüttimeyer, 'Rinder der Tertiär-Epoche.' pl. VI. ('Abh. schw. pal. Ges.' vol. V.)

figures, the fossil agrees with the kudu in all the above-mentioned respects, and also in the contour of the characteristic facial profile, and the position of the horn-core relatively to the orbit. The position of the large lachrymal fissure is still indicated in the fossil. The horn-cores are proportionately somewhat smaller than in the kudu, but their direction may have been approximately similar. This smaller size may be partly due to immaturity, but may also indicate a resemblance to *S. imberbis*. The upper true molars of the existing species of *Strepsiceros* are relatively broad, the outer surface of each lobe being wide and without a distinct median costa; the enamel is rugose, and there is no accessory internal column in the median valley. The teeth of the fossil agree very closely with those of the kudu, with the exception that they possess a distinct internal accessory column,<sup>1</sup> but it is very doubtful if this difference necessarily implies generic distinction. An upper molar of a Siwalik ruminant has been described and figured in vol. III. p. 114. pl. XIII. figs. 9, 10, which it was suggested might possibly belong to the Pikermi genus *Palæoryx*; since, however, this tooth appears to agree precisely with the molars of the present form it is probable that it should be referred to it: the tooth presents the characteristic antelopine (as opposed to cervine) feature of the accessory column being attached entirely to the posterior crescent. When adult it is probable that the fossil species was nearly as large as the kudu.

*Affinities.*—The resemblance of the cranium under consideration to that of the existing *Strepsiceros* is so close that it may safely be regarded as indicating an allied, and probably ancestral form, which may be at least provisionally included in the same genus. This form is certainly specifically distinct from the two existing species, and is larger and otherwise different from *Tragelaphus*, and therefore probably also from *Protragelaphus* (of which the skull is not figured); it is moreover widely different from *Palæoreas*.<sup>2</sup>

*Distribution.*—If the molar figured in vol. III. pl. XIII. figs. 9, 10, belong to the present form, its distribution will have extended from Perim Island to the Punjab.

GENUS. BOSELAPHUS, Blainville.<sup>3</sup>

Syn. *Portax*, Hamilton Smith.

The genus is confined to India, where it has existed since the Siwalik epoch.

BOSELAPHUS, sp. *nobis*.<sup>4</sup>

*Summary.*—This form is known by teeth from the Siwaliks of the Punjab described and figured in vol. III. pp. 114-116. pl. XIII. which with the exception of their superior size are indistinguishable from those of *B. tragocamelus*. The upper

<sup>1</sup> The first true molar of one side has been cleaned in order to exhibit this structure; the accessory column was unfortunately cut through, but its section is visible.

<sup>2</sup> Compare Gaudry, "Les Enchainements, &c.—Mamm. Tert." p. 82. fig. 91.

<sup>3</sup> 'Bull. Soc. Philom. Paris.' 1816. p. 75.

<sup>4</sup> *Supra* vol. III. p. 114 (1884).

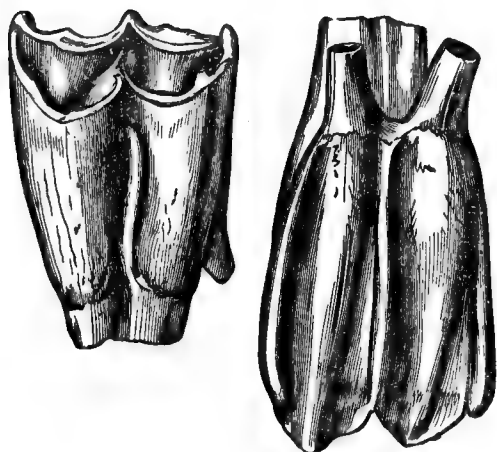


Fig. 1. *Boselaphus tragocamelus* (Pallas). The second left upper true molar, in an almost unworn condition: recent, India.

molars of this genus (*woodcut fig. 1*) are characterized by their broad and tall crowns, the narrow external surfaces of the lobes carrying distinct median costæ, and the tall, narrow, internal accessory column, which is attached entirely to the posterior crescent, and is not expanded antero-posteriorly at its inner termination.<sup>1</sup>

GENUS. PALÆORYX, Gaudry.

The upper molar described and figured in vol. III. p. 114. pl. XIII. figs. 9, 10, which it was suggested might possibly belong to this genus has been shown on the last page to be indistinguishable

from the molars of *Strepsiceros* (?) *falconeri*.

GENUS. HIPPOTRAGUS, Sundevall.<sup>2</sup>

*Distribution*.—The existing species of this genus inhabit tropical and south Africa.

*Species*. HIPPOTRAGUS SIVALENSIS, *nobis*.<sup>3</sup>

*Syn*. *Antilope sivalensis*, *nobis*.<sup>4</sup>

*History*.—The so-called *Antilope sivalensis* was founded on a very imperfect and crushed cranium from the Siwaliks of the Kangra district, which is preserved in the Indian Museum, and is figured in vol. I. pl. XXV. figs. 1, 2 of the present work. A more perfect cranium in the British Museum, was identified by the writer with this species, and at first provisionally,<sup>5</sup> and subsequently more definitely<sup>6</sup> referred to the present genus. The Calcutta specimen has been sent to England and compared with the one in the British Museum; the two are very similar, but the former has a depression on the lachrymal, which is not improbably due to crushing.<sup>7</sup>

*Cranium*.—The British Museum cranium is represented in pl. II. figs. 4, 4a; a cranium of the African *H. niger* being represented in figs. 3, 3a of the same plate. The fossil, which probably belonged to an immature male, shows the bases of the horn-cores, but has lost the nasals, premaxillæ, and a small portion of the occiput; the last two milk-molars are still retained, the third true molar not being protruded from its alveolus. A comparison of the figures will show how extremely close is the resemblance between the recent and fossil crania. Thus both show the absence of a distinct lachrymal depression, the existence of a small elongate lachrymal fissure, and similar supraorbital foramina without pits at their entrance. Both

<sup>1</sup> Unworn teeth of *Cervus aristotelis* present a considerable resemblance to those of *Boselaphus*, but are readily distinguished by their broader and shorter crowns, and by the circumstance that the inner accessory column is attached to both crescents. The distinctive features of the molars of *Hippotragus* will be noticed under the head of that species.

<sup>2</sup> 'K. Svenska Vet-Akad, Handl.' for 1844. p. 196.

<sup>3</sup> *Supra* vol. I. p. 154 (1878)—*Antilope*.

<sup>4</sup> *Loc. cit.*

<sup>5</sup> 'Geol. Mag.' dec. 3. vol. II. p. 170 (1885).

<sup>6</sup> "Cat. Foss. Mamm. Brit. Mus," pt. II. p. 49. No. 39558 (1885).

<sup>7</sup> If this depression should be normal it would indicate that the Calcutta is distinct from the British Museum specimen; in view of which contingency comparisons will be confined to the latter.

show the same narrow muzzle, with a sudden expansion of the maxilla at the infraorbital foramen; in both the orbit is large with a notch below the level of the supraorbital foramen; the horn-cores are similarly situated in respect to the orbits, with a considerable interval between them, and directed at their bases upwards and backwards; there is also the same concave facial profile in the orbital region, and the same strongly-marked ridge descending from the orbit to the first true molar. The palate is generally similar in the two, but the anterior pair of basioccipital tubercles are more approximated in the fossil; both present the same deep concavity in the median line in advance of the premolars. The upper molars of *H. niger* have very broad and nearly square crowns, presenting a remarkably bovine structure; the outer surface of each lobe is relatively wide, with a strongly-marked median costa, and there is a large internal accessory column, of which the inner termination is expanded antero-posteriorly.<sup>1</sup> The imperfect protrusion of the molars of the fossil specimen renders their distinctive features obscure, but mm 4 agrees in general characters with those of the existing species. The united length of m. 1 and m. 2 is nearly the same as in *H. niger*, and thus indicates that adult male specimens of the fossil were about equal in size to that species. On the assumption that the Calcutta specimen is specifically the same as the British Museum cranium, it will probably indicate a female individual.

*Affinities.*—The resemblance between the British Museum Siwalik cranium and that of *H. niger* is so close as to leave little doubt that the two species are generically the same, and in any case that they are very closely allied. No other fossil species of the genus appear to have been recorded; and of the existing species *H. niger* and *H. leucophæus* are confined to south Africa, while *H. equinus* ranges into Nubia and the adjacent districts.

Genus. GAZELLA, Blainville.<sup>2</sup>

*Distribution.*—This genus has a wide distribution at the present day, being most abundant in the deserts on the borders of the Palæarctic, Oriental, and Ethiopian regions; its range in Europe extends from the lower pliocene of Pikermi to the Norwich Crag.<sup>3</sup>

Species. GAZELLA PORRECTICORNIS, nobis.<sup>4</sup>

Syn. *Antilope porrecticornis*, nobis.<sup>5</sup>

*History.*—This species was founded upon the left half of a frontlet and horn-core figured in vol. I. pl. XXV. fig. 4, which was there stated to be allied to the gazelles, and was subsequently referred to the present genus.<sup>6</sup>

*Frontlet.*—The type specimen is represented in the accompanying woodcut (fig. 2), the right half having been restored. The frontal is complete with the

<sup>1</sup> The inner expansion of this column at once distinguishes the molars of *Hippotragus niger* from those of *Boselaphus*, in which the crowns and the base of the outer surfaces of the lobes are relatively narrower.

<sup>2</sup> 'Bull. Soc. Philom. Paris.' 1816. p. 75.

<sup>3</sup> *G. anglica*, Newton.

<sup>4</sup> *Supra* vol. I. p. 158 (1878)—*Antilope*.

<sup>5</sup> *Loc. cit.*

<sup>6</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 50.

exception of the process descending on the outer side of the nasal, while the horn-

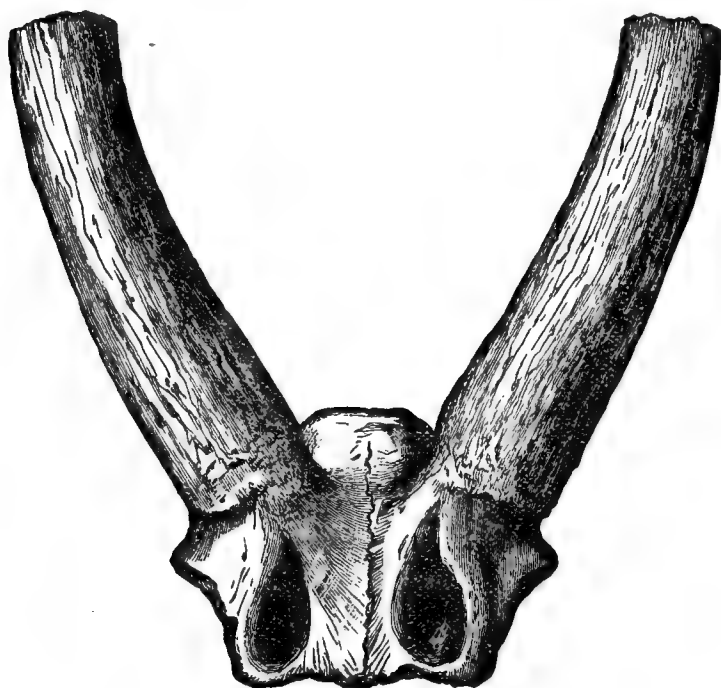


Fig. 2. *Gazella porrecticornis*. The frontlet; from the Siwaliks of the Punjab.  $\frac{1}{2}$ . Indian Museum (No. B. 229).

core has lost about one-quarter of its length. In the laterally compressed horn-core, the form and position of the supraorbital foramen and sulcus, and the relative shortness of the frontal,<sup>1</sup> the specimen agrees so exactly with the gazelles, that its reference to the present genus may be considered certain. It indicates a considerably larger species than the Indian *G. bennetti*, and in this respect agrees with the east African *G. granti*, although differing slightly in the form of the supraorbital sulcus and the curvature of the horn-core. It agrees with that species in the extreme shortness of the frontal; but unfortu-

nately it cannot be determined whether it also agreed in the absence of the lachrymal depression, which is present in *G. bennetti*.

#### GAZELLA, sp.

*Frontlet*.—The frontlet represented in pl. IV. fig. 6 was obtained from Niki in the Punjab,<sup>2</sup> and has hitherto been included in the preceding species; it agrees exactly in size with the frontlet of a male of *G. bennetti*, and if adult, as appears to be the case, is too small to be the female of *G. porrecticornis*. The specimen is too imperfect to afford a specific diagnosis, but it not improbably indicates the existence in the Siwaliks of the Punjab of a gazelle closely allied to the living Indian species.

#### GENUS. COBUS, A. Smith.<sup>3</sup>

Including *Adenota* and *Onotragus*, Gray.

*Distribution*.—The genus includes a considerable number of species inhabiting tropical Africa. An antelope has been described by M. P. Thomas<sup>4</sup> under the name of *Antilope tournouëri* from the upper pliocene of Algeria, which is regarded as allied to the present genus.

#### Species 1. COBUS (?) PALÆINDICUS, nobis.<sup>5</sup>

*History*.—This species was founded on an imperfect cranium in the British Museum (No. M. 2402) from the Siwalik Hills, which was provisionally referred to the present genus.

<sup>1</sup> These, among other characters, distinguish *Gazella* from *Cobus*.

<sup>2</sup> "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 20. No. B. 228.

<sup>3</sup> "Illustra. Zool. of S. Africa." No. 12 (1840), *Kobus*.

<sup>4</sup> 'Mém. Soc. Géol. France.' ser. 3. vol. III. art. 2. p. 15. pl. VII. fig. 1 (1884).

<sup>5</sup> "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 53 (1885).



*Cranium*.—The type cranium is represented in pl. III. figs. 1, 1a; a cranium of the existing *Cobus sing-sing* being represented in figs. 4, 4a. The fossil, which wants the horn-cores, and is otherwise damaged, indicates a species about one-third smaller than *C. ellipsiprymnus* and *C. sing-sing*. It agrees with the figured recent cranium of the latter in the large frontal depression and foramina, the presence of an infraorbital fissure and absence of a lachrymal depression, as well as in general contour, position of the orbits, setting on of the horn-cores, and the marked ridges bordering the temporal fossæ; it also agrees in the form of the basioccipital tubercles, of the tympanic bullæ, and of the hinder part of the palate. The molars of the existing species are narrow, and have narrow external lobes with a strongly-marked median costa, and no inner accessory column; in all of which respects those of the fossil cranium agree. The latter is, however, narrower than the cranium of *C. sing-sing*, its post-cornual portion relatively longer, and the angle formed by the meeting of the nasal and parietal planes considerably less open. In the two latter respects the species generically separated by Gray under the name of *Adenota*<sup>1</sup> make a nearer approach to the fossil, while *Cobus leucotis* comes perhaps still nearer in these points, and also agrees in size.

A second Siwalik cranium in the British Museum (No. M. 487)<sup>2</sup> is in very nearly the same condition as the type, with which it agrees almost exactly, although rather wider.

The hinder portion of a cranium represented in figs. 2, 2a of plate III. is also from the Siwalik Hills, and is preserved in the British Museum (No. 39559); it agrees with the type cranium in essential characters, and is therefore provisionally referred to the same species. The horn-cores are widely separated, rounded, and directed upwards, backwards, and somewhat outwards; the horns, as in *C. sing-sing*, may have been lyrate. The relatively large size of the post-cornual portion of the cranium and the comparatively sharp angle at the junction of the nasal and parietal planes are well exhibited in this specimen.

The females of the existing species of *Cobus* are hornless, and as there is in the British Museum the hornless cranium of an antelope (No. 39569<sup>3</sup>) from the Siwalik Hills, which agrees with the present form in size, general contour, and structure of the molar teeth, it is highly probable that it belongs either to this or the next species.

*Affinities*.—The close resemblance existing between the specimens described above and the crania of the genus *Cobus*, together with the strong evidence in favour of the female of the Siwalik form having been hornless, indicates that the recent and fossil forms are closely allied, and justifies at least the provisional reference of the latter to the existing genus.

*Distribution*.—All the specimens referred to this species were obtained from the typical Siwalik Hills.

<sup>1</sup> Compare "Cat. Mamm. Brit. Mus.—pt. III. Ungulata Furcipedæ," pl. XI. fig. 1 (1852).

<sup>2</sup> This specimen was overlooked when part II. of the Brit. Mus. Catalogue was written.

<sup>3</sup> "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 58.

Species 2. *COBUS* (?) *PATULICORNIS*, *nobis*.<sup>1</sup>

Syn. *Antilope patulicornis*, *nobis*.<sup>2</sup>

*History*.—This species was originally described on the evidence of an imperfect frontlet figured in vol. I. pl. XXV. fig. 3, which was provisionally referred to the present genus in the "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 54, where several imperfect specimens of the cranium are recorded.

*Cranium*.—The best preserved of the British Museum specimens (No. 39559, a) is represented in plate III. figs. 3, 3a, and consists of the hinder part of the cranium bearing the basal halves of the horn-cores.<sup>3</sup> In general characters this specimen agrees with the cranium of the preceding species, but is readily distinguished by the more widely divergent horn-cores; in which respect it also differs from existing species of *Cobus*.

*Affinities*.—The resemblance of the cranium of the present form to that of the preceding species renders it probable that it should be referred to the same genus, but more perfect specimens are required before its affinities can be further elucidated.

*Distribution*.—The type specimen was obtained from the Hushiárpur district, while the British Museum examples were derived from the typical Siwalik Hills.

GENUS, *non. det.*

*Frontal*.—The frontal and horn-core represented in pl. III. fig. 5 was obtained from Perim Island, and is described in the "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 54 as of the left side, but it is very difficult to say to which side it really belongs, and it is here figured as belonging to the right.<sup>4</sup> It has the depressed frontal region and the widely separated horn-cores of *Cobus*, and if it belong to the left side the direction of the horn-cores is nearly the same as in existing species of that genus; if, however, it is here figured in the right position their curvature is reversed. More perfect specimens are required to elucidate the full affinities of this large antelope.

GENUS. *ALCELAPHUS*, Blainville.<sup>5</sup>

Including *Damalis*, Gray.

*Distribution*.—There are some nine or ten existing species, ranging over the whole of Africa, and extending north-eastward into Syria. *A. bubalis* occurs fossil in the upper pleistocene of Algiers.<sup>6</sup>

Species. *ALCELAPHUS PALÆINDICUS* (Falconer<sup>7</sup>).

Syn. *Antilope palæindica*, Falconer.<sup>8</sup>

*Alcelaphus bakeri*, Lydekker.<sup>9</sup>

*History*.—The history of this species will be found in vol. III. p. 117, and in the "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 55.

<sup>1</sup> *Supra*. vol. I. p. 157 (1878)—*Antilope*.

<sup>2</sup> *Loc. cit.*

<sup>3</sup> The artist has unfortunately not drawn fig. 3 in the same position as the other specimens, the occipital portion having been too much elevated.

<sup>4</sup> If the specimen belong to the left side the right side of the figure is the inferior border.

<sup>5</sup> 'Bull. Soc. Philom. Paris.' 1816. p. 75.

<sup>6</sup> Thomas. 'Mém. Soc. Géol. France.' ser. 3. vol. III. art. 2. p. 38 (1884).

<sup>7</sup> "Cat. Foss. Vert. As. Soc. Beng." p. 154 (1859).

<sup>8</sup> *Loc. cit.*

<sup>9</sup> 'Geol. Mag.' dec. 3. vol. II. p. 170 (1885).



*Cranium.*—The type cranium is represented in pl. IV. figs. 4, 4a, and a second specimen in fig. 5; the former shows the greater part of the face, but lacks the hinder part of the occiput, while the latter shows the whole of the occiput, but has lost the anterior part of the face; there are some slight differences in these two specimens, which cannot, however, be regarded as of more than individual value.

The general contour of the skull indicates without doubt that the species belongs to *Alcelaphus*, and in order to exhibit this affinity the crania of the existing *A. tora* (fig. 1) and *A. pygargus* (fig. 2) have been figured for comparison.<sup>1</sup> The fossil agrees with *A. tora* (with which may be grouped *A. caama* and *A. bubalis*) in its extremely elongated face, characterized by the straight infraorbital profile, and the long terminally-expanded nasals, which form a bold median ridge bounded by deep hollows in the lachrymals and maxillæ. The horn-cores are, however, placed directly over the orbit as in *A. pygargus* (which agrees in this respect with *A. albifrons* and *A. senegalensis*), instead of being pushed back to the vertex of the cranium as in the *A. tora* group,<sup>2</sup> and the occipital and parietal planes are consequently distinct, as in the former group.<sup>3</sup> The direction of the horn-cores is nearly the same as in the *A. pygargus* group, which also agrees with the fossil in the concavity of the facial profile at the orbit, although differing in the perfect straightness of the infraorbital portion.

*Young cranium.*—The young cranium represented in figs. 3, 3a, is the type of *A. bakeri*, which was regarded as allied to the *A. pygargus* group. The opportunity of comparing this specimen with the one represented in fig. 5 has, however, convinced the writer that the two cannot apparently be specifically separated; the shorter face of the young specimen being probably due to its immaturity.

*Molars.*—The second and third left upper true molars of the Calcutta specimen are represented in fig. 5a. These teeth agree with those of existing species of the genus in their extremely narrow form, and the absence of any trace of the internal accessory column.

*Affinities.*—The present species may apparently be regarded as one intermediate between the *A. tora* and the *A. pygargus* group, being allied to the former in the characters of the face, and to the latter in those of the postorbital portion of the cranium. Judging from the analogy of the genus *Bos*, the *A. tora* group is the more specialized of the two, and as it is probable that the facial would be more readily modified than the occipital region of the cranium, it is interesting to find that in the Siwalik form it is this part which has assumed the specialized character. The intermediate nature of *A. palæindicus* fully confirms the conclusion now generally entertained as to the generic unity of the *A. tora* and *A. pygargus* groups.

<sup>1</sup> The absence of a lachrymal fissure and of supraorbital pits, the presence of a well-marked lachrymal depression, and the narrow crowns of the cheek-teeth are characteristic features of the genus.

<sup>2</sup> Compare Gray "Cat. Mamm. Brit. Mus.—pt. III. Ungulata Furcipedæ." pl. xvi. fig. 1 (1852).

<sup>3</sup> When describing the type specimen in the "Cat. Foss. Mamm. Brit. Mus." pt. II. the writer thought that the post-cornual portion of the cranium would be much shorter than it really turns out to be, and he therefore considered the species nearer to the *A. tora* group than now seems to be the case.

*Distribution.*—All the known remains<sup>1</sup> of this species have been obtained from the typical Siwalik Hills.

### III. THE GENUS MERYCOPOTAMUS.

*Present notice.*—The chief characters of this genus have been already described in the present work<sup>2</sup> and in the "Cat. Foss. Mamm. Brit. Mus.,"<sup>3</sup> and the object of the present notice is to give figures on a scale sufficiently large to illustrate some of the characteristic features of the two larger typical species. The structure of the upper molars of the small *M. pusillus* renders it probable that *Hemimeryx*<sup>4</sup> must be included in the present genus.

#### Species 1. MERYCOPOTAMUS DISSIMILIS, Falc. and Caut.<sup>5</sup>

*Characters.*—This species is of comparatively large size, and characterized by the wide mandibular symphysis, the long jaws, the comparatively straight profile and slight vertical depth of the cranium, the presence of a deep fossa on the outer side of the mandible of the male behind the canine, and the nearly flat inner surface of the third lobe of  $\overline{m.3}$  in the same sex. The canines are proportionately smaller than in the next species.

*Cranium.*—The type cranium is represented in the "Fauna Antiqua Sivalensis," pl. LXVII. figs. 1, 1a, on a reduced scale; a full-sized view of the last four cheek-teeth being given in pl. V. fig. 1 of this memoir. As the anterior part of this specimen is unfortunately wanting the size of the canine cannot be determined, but the large dimensions of the cranium indicates that it belonged to a male. The straightness of the cranial profile is well shown in the original figures; the length of the space occupied by the three true molars (of which the last is almost unworn) is 3.2 inches.

In pl. V. fig. 2 there is given the palatal view of the anterior part of a cranium collected by Mr. Theobald near Bhimber, which may provisionally be regarded as belonging to a female<sup>6</sup> of the present species. The specimen is considerably damaged, but exhibits nearly all the cheek-teeth, portions of the canines, and the broken bases or alveoli of the incisors. In its general contour and low elevation the cranium agrees with the type specimen, but is of considerably smaller dimensions, the length of the space occupied by the three true molars being 2.8, and the interval between the canine and the hinder border of  $\overline{m.3}$  6.2 inches. The structure of the cheek-teeth is similar to that of the type specimen<sup>7</sup>; the canines are comparatively small, and have an antero-posterior diameter of 0.7 inch. The structure of the palate agrees generally with that obtaining in *Sus*, and exhibits similar large foramina; it is, however, relatively wider, and the incisors are of subequal size. In the two latter respects the genus agrees more nearly with *Hippopotamus*; and similar features are

<sup>1</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 55-6, and "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 20.

<sup>2</sup> Vol. II. p. 165. The feet were tetradactylate.

<sup>3</sup> Part II. p. 209.

<sup>4</sup> *Supra.* vol. II. p. 167 pl. XXIII. fig. 5.

<sup>5</sup> 'Asiatic Researches.' vol. XIX. p. 51 (1836)—*Hippopotamus*.

<sup>6</sup> It is entered in the "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 38 (No. B. 110) as belonging to a small male.

<sup>7</sup> Those of the type specimen are viewed more from the external surface.

exhibited by the reëntering angle formed by the anterior termination of the nasals, the backward position of the fronto-nasal suture, and the general contour of the facial aspect of the cranium.

*Mandible*.—The right ramus of the mandible of a male of this species figured by Falconer and Cautley in the "Fauna Antiqua Sivalensis," pl. LXVII. figs. 4, 4a,<sup>1</sup> is refigured on a larger scale in pl. V. fig. 3. The length of the space occupied by the three true molars is 3·45, the interval between the canine and the hinder border of  $\overline{m.3}$  7·8, and the antero-posterior diameter of the canine 1·15 inches; these dimensions agreeing very closely with those of the male cranium. The hippopotamine features presented by this specimen have been described in previous notices.

There are no complete specimens known of the mandibular ramus of the female of this species; and it is very difficult to make specific determinations in the case of imperfect specimens. The left half of a symphysis has been referred to a female in the "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 211. No. 18444, and it is not improbable that the immature specimen No. 17002 noticed on the same page may also belong to this sex. The hinder part of a right mandibular ramus from the Punjab figured in pl. VI. fig. 3. agrees with the latter specimen, and also accords in size with the female cranium figured in pl. V. fig. 2. The third true molar is narrower than the corresponding tooth in the jaw of the male of the present species, and in the two figured jaws of *M. nanus* (pl. VI. figs. 4, 5).

*Distribution*.—A young cranium from Burma is referred to this species in the "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 38. No. B. 112, and the range of the species seems therefore to have extended from the Punjab to Burma.

Species 2. *MERYCOPOTAMUS NANUS*, *nobis*.<sup>2</sup>

*Characters*.—This species is smaller than the last, and is characterized by the narrower mandibular symphysis, the relatively shorter jaws, the convex profile and great vertical depth of the cranium, the absence of a deep fossa behind the lower canine of the male, and the deep concavity of the outer surface of the third lobe of  $\overline{m.3}$ . The canines are of great relative size.

*Cranium*.—The cranium of a male of this species figured in the "Fauna Antiqua Sivalensis," pl. LXVII. figs. 3, 3a,<sup>3</sup> is refigured on a larger scale from the palatal aspect in pl. VI. fig. 1 of this memoir. The length of the space occupied by the three true molars is 2·6, the interval between the canine and the hinder border of  $\overline{m.3}$  5·55, and the antero-posterior diameter of the canine 0·86 inches. Contrasting this figure with that of the female cranium of *M. dissimilis* (pl. V. fig. 2), the characteristic shortness of the jaw is well exhibited, and this would be still more marked if the male cranium of which the cheek-dentition is represented in pl. V. fig. 1. were sufficiently complete to exhibit the whole of the dental series.

A female cranium is figured on a scale of one-third in the "Fauna Antiqua

<sup>1</sup> Also in pl. LXII. fig. 16, on a scale of  $\frac{1}{2}$ .

<sup>2</sup> 'Geol. Mag.' dec. 3. vol. I. p. 545 (1884). The specimens of this species figured in the "Fauna Antiqua Sivalensis," were all referred to *M. dissimilis*.

<sup>3</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 211. No. 16551.

Sivalensis," pl. LXVII. figs. 5, 5a,<sup>1</sup> the left half of the palate being also figured on a scale of one-half in pl. LXII. fig. 15.<sup>2</sup> The length of the space occupied by the three true molars is 2·6,<sup>3</sup> the interval between the canine and the hinder border of m. 3 5·3, and the antero-posterior diameter of the canine 0·7 inches. The characteristic convex profile and great vertical height of the cranium are well shown in this specimen.<sup>4</sup> The middle part of a very old cranium from the Punjab in the Indian Museum, of which the left dentition is represented in pl. VI. fig. 2, agrees very closely with this specimen. The teeth are very much worn, and the premolars are broken; the three true molars occupy a space of 2·46 inches. The dimensions of these two specimens differ very greatly from those of the female cranium of *M. dissimilis* represented in pl. V. fig. 2.

*Mandible*.—The left ramus of the mandible of a male figured in the "Fauna Antiqua Sivalensis," pl. LXVII. figs. 8, 8a<sup>5</sup> is refigured on a larger scale in pl. VI. fig. 4. The inner side of the specimen is not cleared from matrix, and the necessary foreshortening of the canine (*c.*) does not give a good idea of the large size of this tooth. In relative dimensions this specimen agrees precisely with the male cranium represented in fig. 1, the length of the space occupied by the three true molars being 2·7, the interval between the canine and the hinder border of m. 3 6·4, and the antero-posterior diameter of the canine 1·18 inches. The remarkable difference between this specimen and the male mandible of *M. dissimilis* represented in pl. V. fig. 3 will be apparent from a comparison of the figures and dimensions.

In plate VI. fig. 5 a larger view is given of a female mandibular ramus figured in the "Fauna Antiqua Sivalensis," pl. LXVII. figs. 7, 7a.<sup>6</sup> The specimen belongs to the right side, and shows the last true molar in a half-worn condition, the bases of the preceding cheek-teeth, and a section of the canine (*c.*). The interval between the latter and the hinder border of m. 3 seems to have been nearly the same as in the male specimen, but the antero-posterior diameter of the base of the canine is only 0·78 inch.

*Distribution*.—Assuming that the specimen represented in pl. VI. fig. 2 is rightly referred to the present species, the range of the latter will have extended from the Siwalik Hills to the Punjab.

### Species 3. MERYCOPOTAMUS PUSILLUS, *nobis*.<sup>6</sup>

The characteristic features of the third upper true molar on which this small species is founded have been already described in the preceding volume of this work (pp. XII.-XIII).

<sup>1</sup> "Cat. Foss. Mam. Brit." pt. II. p. 212. No. 16552.    <sup>2</sup> Wrongly entered as the lower jaw in the description of the plate.

<sup>3</sup> Owing to the worn condition of m. 1 in the male cranium the length of the molar series is abnormally short.

<sup>4</sup> See the figures in the "F. A. S."

<sup>5</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 212. No. 18407.

<sup>6</sup> "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 212. No. 15349.

## POSTSCRIPT.

It should have been observed that the reference of *Antilope torticornis*, Aymard, to *Palæoreas* is on the authority of M. P. Thomas ('Mém. Soc. Géol. France.' ser. 3. vol. III. art. 2. p. 16), and that it is referred by M. Depéret in the passage quoted in the text to *Tragelaphus*. According to Prof. Rüttimeyer's description ('Die. Rinder der Tertiär-Epoche, etc.' p. 85) the molars of this form are very similar to those of *Strepsiceros* (?) *falconeri*. Since the text was in type the writer has noticed that a tooth from the 'Bohnerzgruben' of Würtemberg has been described by Prof. Rüttimeyer (see p. 88 of the work cited) as *Hippotragus fraasi*. If this determination and the reference of *A. torticornis* to *Tragelaphus* rather than to *Palæoreas* be correct, there is evidence of the occurrence of two existing African genera of antelopes in the tertiaries of Europe.

## PLATE I.

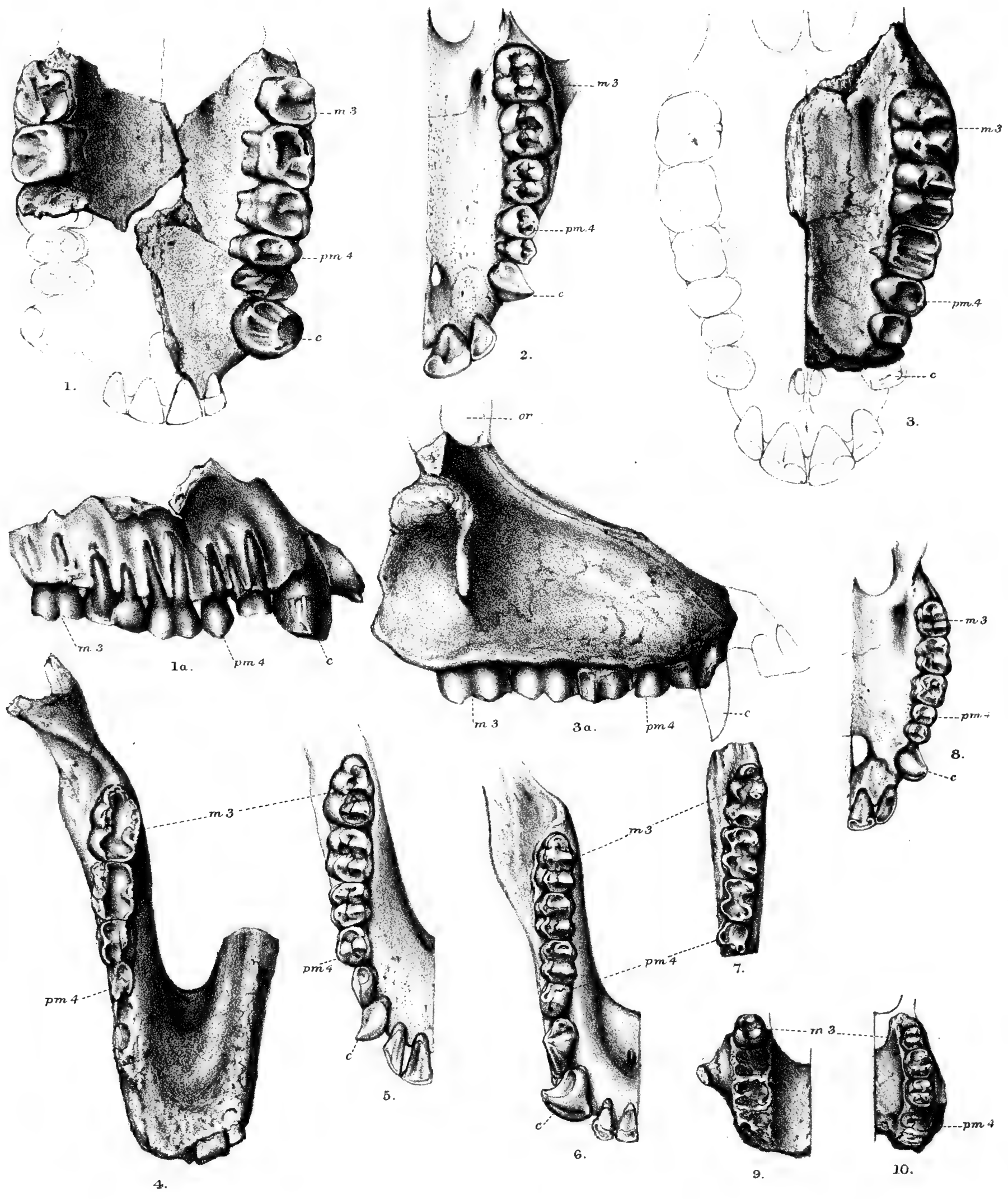
### PRIMATES — *Simiidae* and *Cercopithecidae*.

- Figs. 1, 1a, TROGLODYTES SIVALENSIS, Lyd. The imperfect palate of a male from Jabi, Punjab. Indian Museum (No. D. 1). *Page 2.*
- „ 2. CYNOCEPHALUS BABOUIN, Desm. The right half of the palate of a female; Africa. British Museum (No. 36. C).
- „ 3, 3a. CYNOCEPHALUS SUBHIMALAYANUS (Meyer). The imperfect right half of the facial portion of the cranium of a female; from the Siwalik Hills. British Museum (No. 81157). *Page 6.*
- „ 4. CYNOCEPHALUS FALCONERI, Lyd. The imperfect mandible of a male; from the Siwalik Hills. British Museum (No. 15709). *Page 7.*
- „ 5. CYNOCEPHALUS BABOUIN, Desm. The right ramus of the mandible belonging to the same individual as the palate represented in fig. 2.
- „ 6. SEMNOPITHECUS SCHISTACEUS (Hodgson). The right ramus of the mandible of a male; Kashmir.
- „ 7. SEMNOPITHECUS PALÆINDICUS, Lyd. Part of the right ramus of the mandible of a male (?); from the Siwalik Hills. British Museum (No. 15710). *Page 5.*
- „ 8. MACACUS RHESUS (Audebert). The right half of the palate of a male; India.
- „ 9. MACACUS SIVALENSIS, Lyd. Part of the left maxilla; from the Siwaliks of the Punjab. Indian Museum (No. D. 2). *Page 5.*
- „ 10. MACACUS SIVALENSIS, Lyd. Part of the right maxilla of an immature individual; from the Siwaliks of the Punjab. Indian Museum (No. D. 2, a). *Page 5.*

---

\* All the figures natural size.







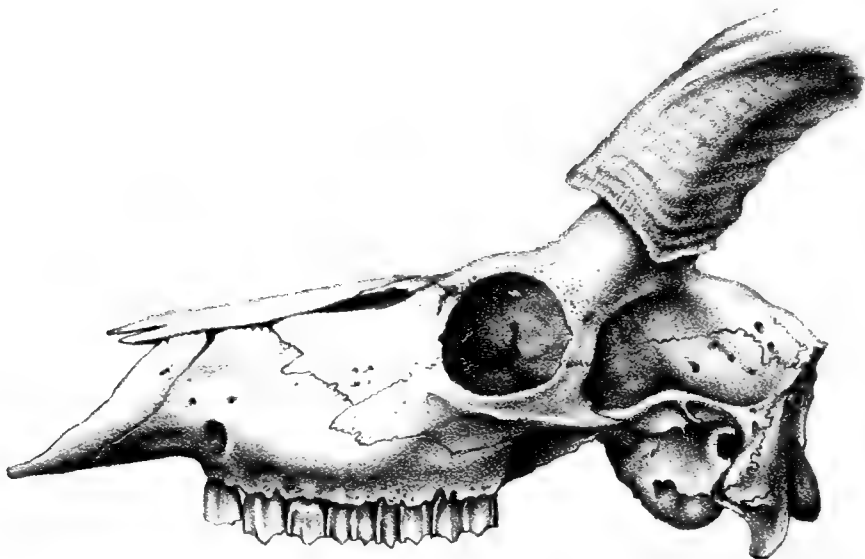




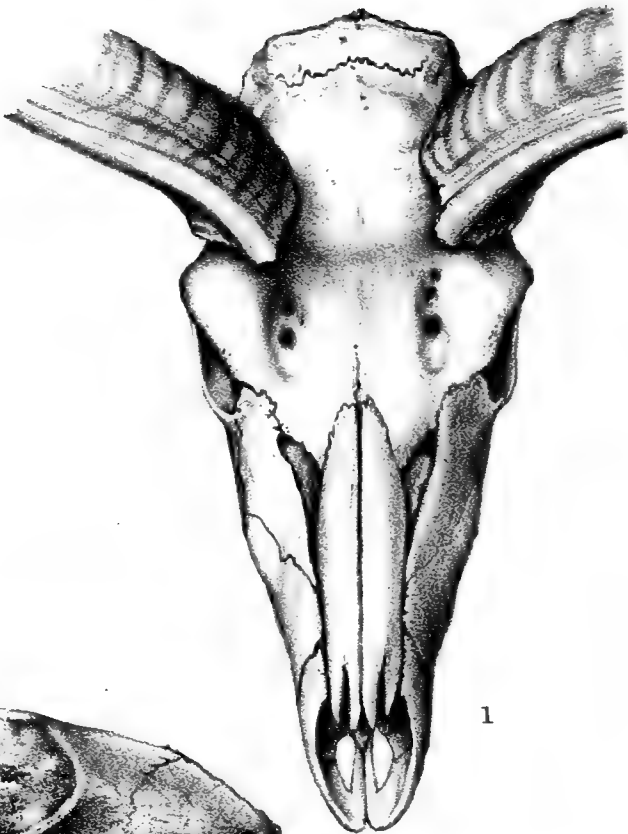
## PLATE II.

### ARTIODACTYLA — *Bovidæ*.

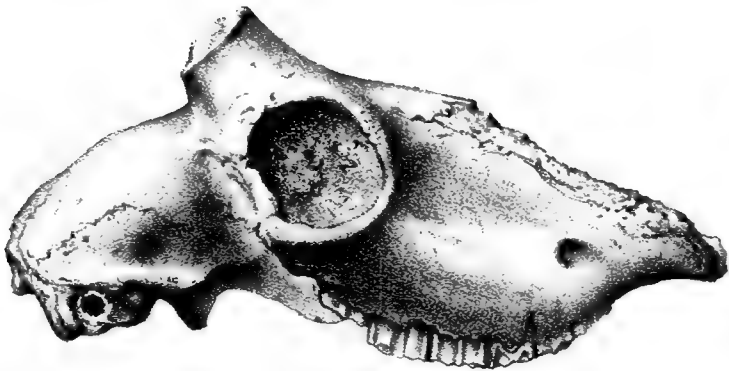
- Figs. 1, 1a. *STREPSICEROS KUDU*, Gray. Cranium ; S. Africa.  $\frac{1}{4}$ . British Museum (No. 646,n).
- „ 2, 2a. *STREPSICEROS* (?) *FALCONERI*, Lyd. Immature cranium ; from the Siwalik Hills.  $\frac{1}{3}$ . British Museum (No. 37262). *Page* 8.
- „ 3, 3a. *HIPPOTRAGUS NIGER* (Harris). Cranium ; S. Africa.  $\frac{1}{4}$ . British Museum (No. 1038,a).
- „ 4, 4a. *HIPPOTRAGUS SIVALENSIS*, Lyd. Immature cranium ; from the Siwalik Hills.  $\frac{1}{3}$ . British Museum (No. 39558). *Page* 10.



1a



1



4a



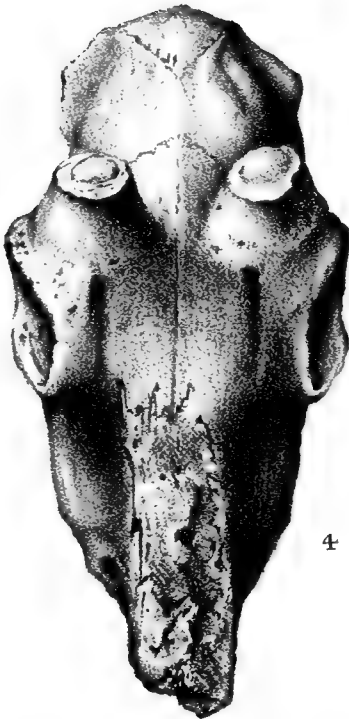
2a



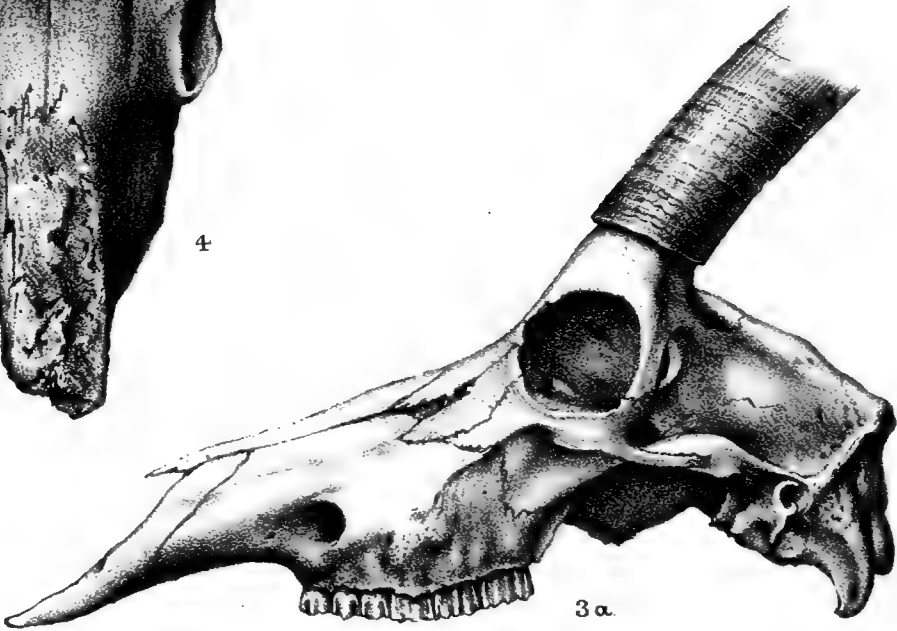
2



3



4



3a





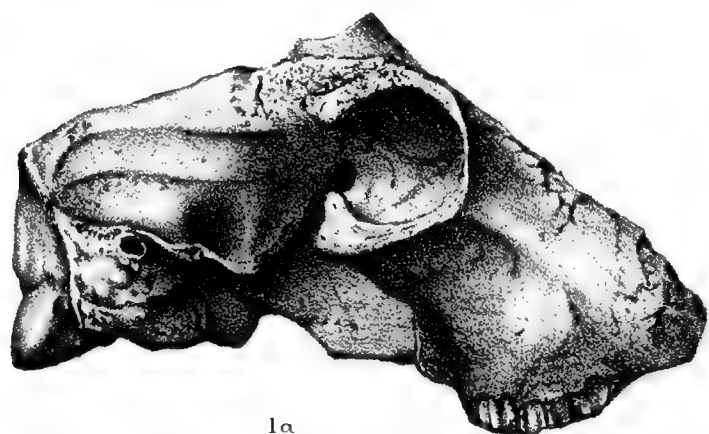
## PLATE III.

### ARTIODACTYLA — *Bovidæ*.

- Figs. 1, 1a. COBUS (?) PALÆINDICUS, Lyd. Cranium; from the Siwalik Hills. British Museum (No. M.2402). *Page 13.*
- „ 2, 2a. COBUS (?) PALÆINDICUS, Lyd. Hinder half of the cranium; from the Siwalik Hills. British Museum (No. 39559). *Page 13.*
- „ 3, 3a. COBUS (?) PATULICORNIS, Lyd. Hinder half of the cranium; from the Siwalik Hills. British Museum (No. 39559, a). *Page 14.*
- „ 4, 4a. COBUS SING-SING (Bennett). Cranium; W. Africa. British Museum (No. 744,e).
- „ 5. GENUS *non. det.* A frontal; from Perim Island. British Museum (No. M.2402,a). *Page 14.*

---

\* Figs. 4, 4a  $\frac{1}{4}$ , the rest  $\frac{1}{2}$  nat. size. In fig. 3 the occiput has been more elevated than in figs. 1, 2, 4.



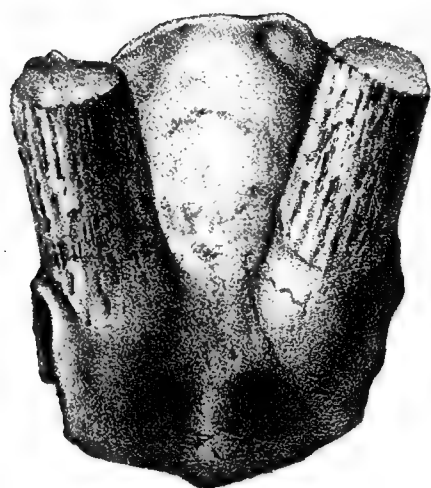
1a



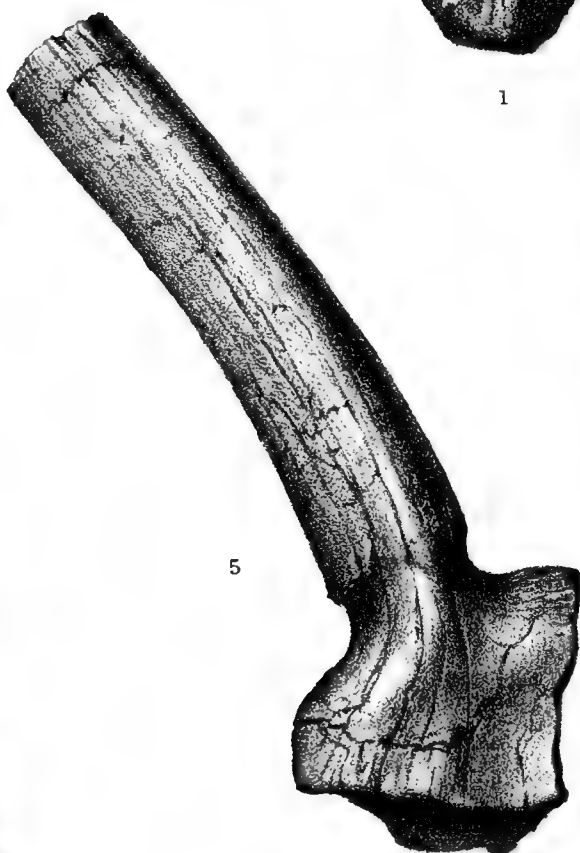
1



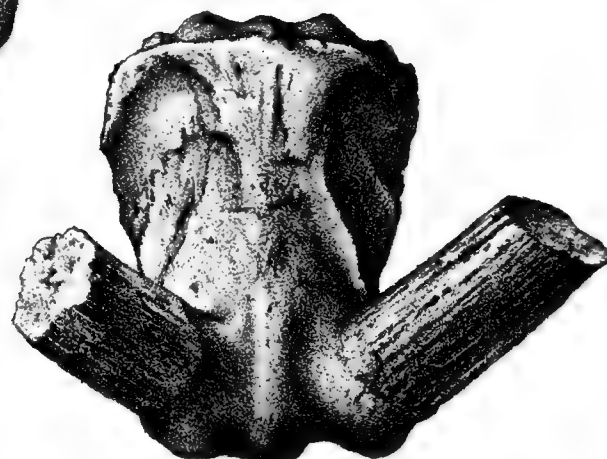
3a



2



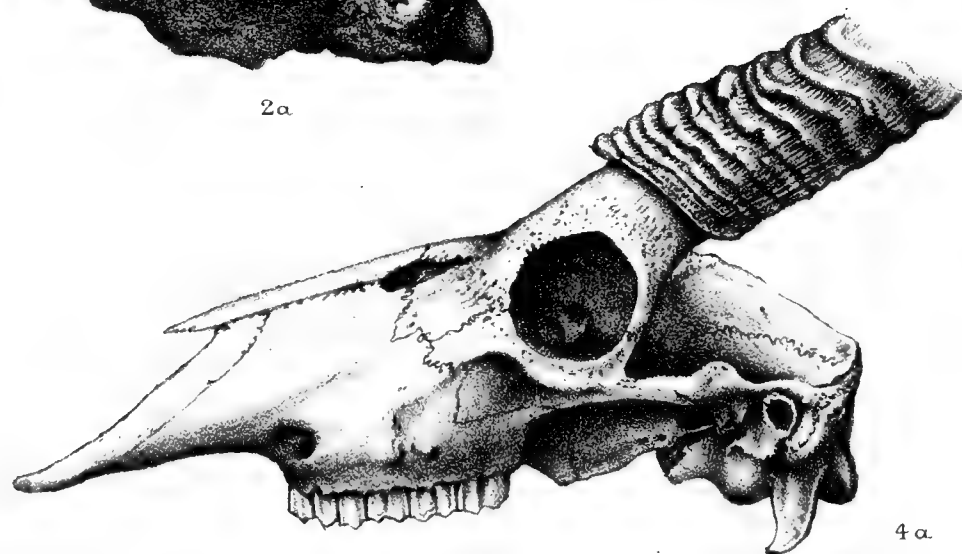
5



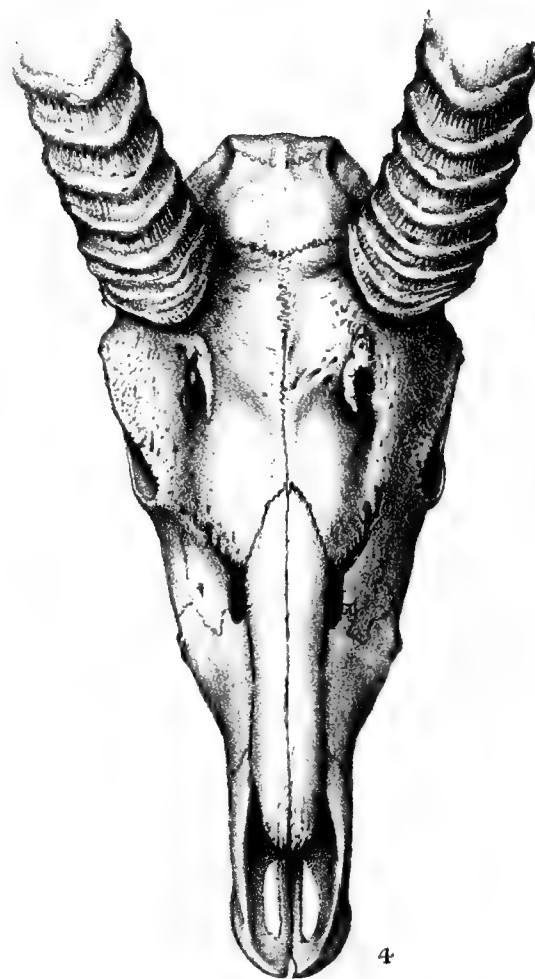
3



2a



4a



4







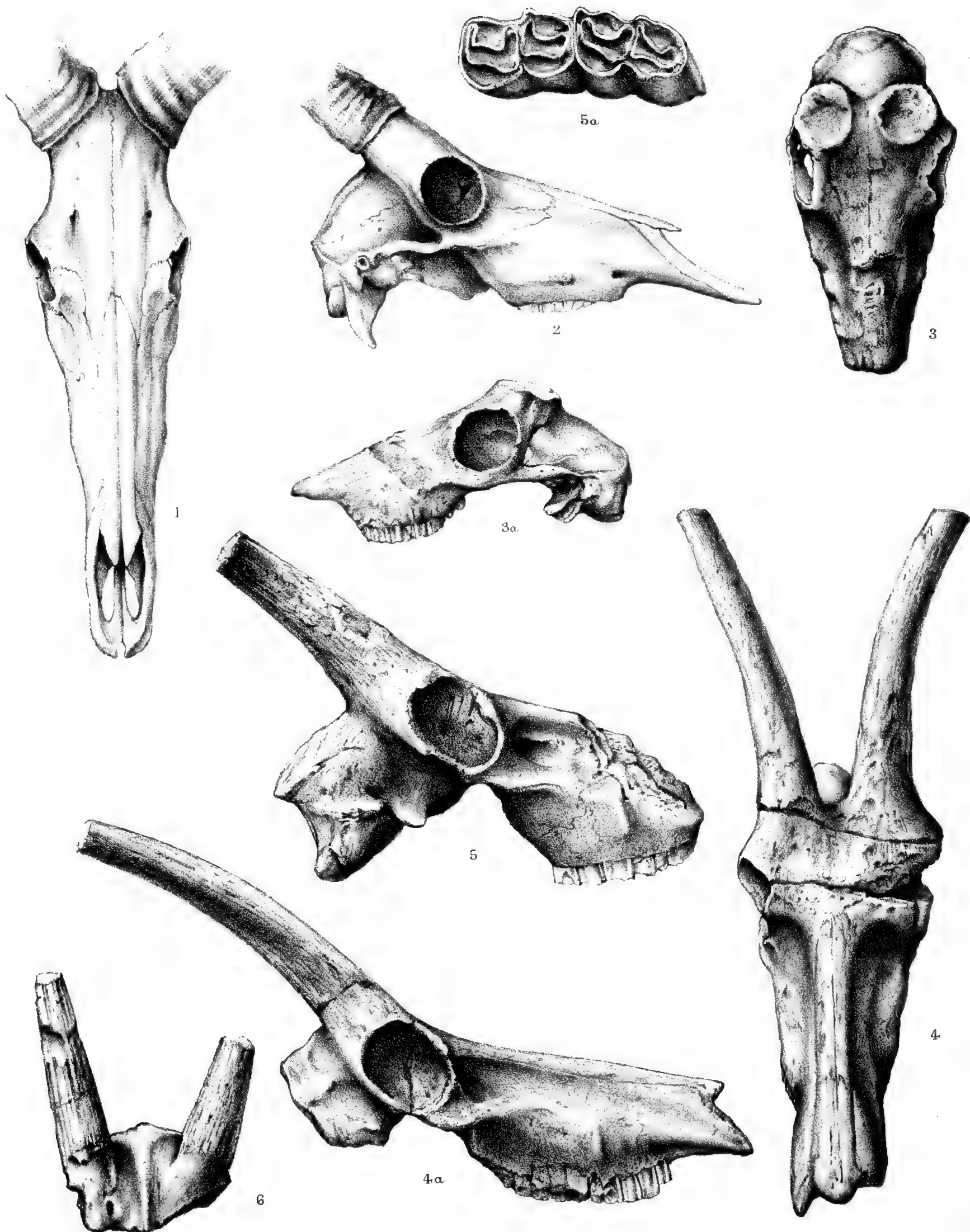
## PLATE IV.

### ARTIODACTYLA — *Bovidae*.

- Fig. 1.     ALCELAPHUS TORA, Gray.   Cranium ; Abyssinia.   British Museum (No. 1647,d).
- „   2.     ALCELAPHUS PYGARGUS (Pallas).   Cranium ; South Africa.   British Museum (No. 644,a).
- „   3, 3a.   ALCELAPHUS PALÆINDICUS (Falconer).   Immature cranium ; from the Siwalik Hills.  
                  British Museum (No. 39598).   *Page* 15.
- „   4, 4a.   ALCELAPHUS PALÆINDICUS (Falconer).   Cranium ; from the Siwalik Hills.   British Museum  
                  (No. 39594).   *Page* 15.
- „   5, 5a.   ALCELAPHUS PALÆINDICUS (Falconer).   Cranium and m. 2 and m. 3 ; from the Siwalik  
                  Hills.   Indian Museum (No. B. 331).   *Page* 15.
- „   6.     GAZELLA, sp.   Frontlet ; from the Siwaliks of the Punjab.   Indian Museum (No. B.228,a).  
                  *Page* 12.

---

\*   *Figs.* 1, 2,  $\frac{1}{4}$  ; *figs.* 3, 3a, 4, 4a, 5,  $\frac{1}{3}$  ; *fig.* 6,  $\frac{1}{2}$  ; *fig.* 5a,  $\frac{1}{1}$ .







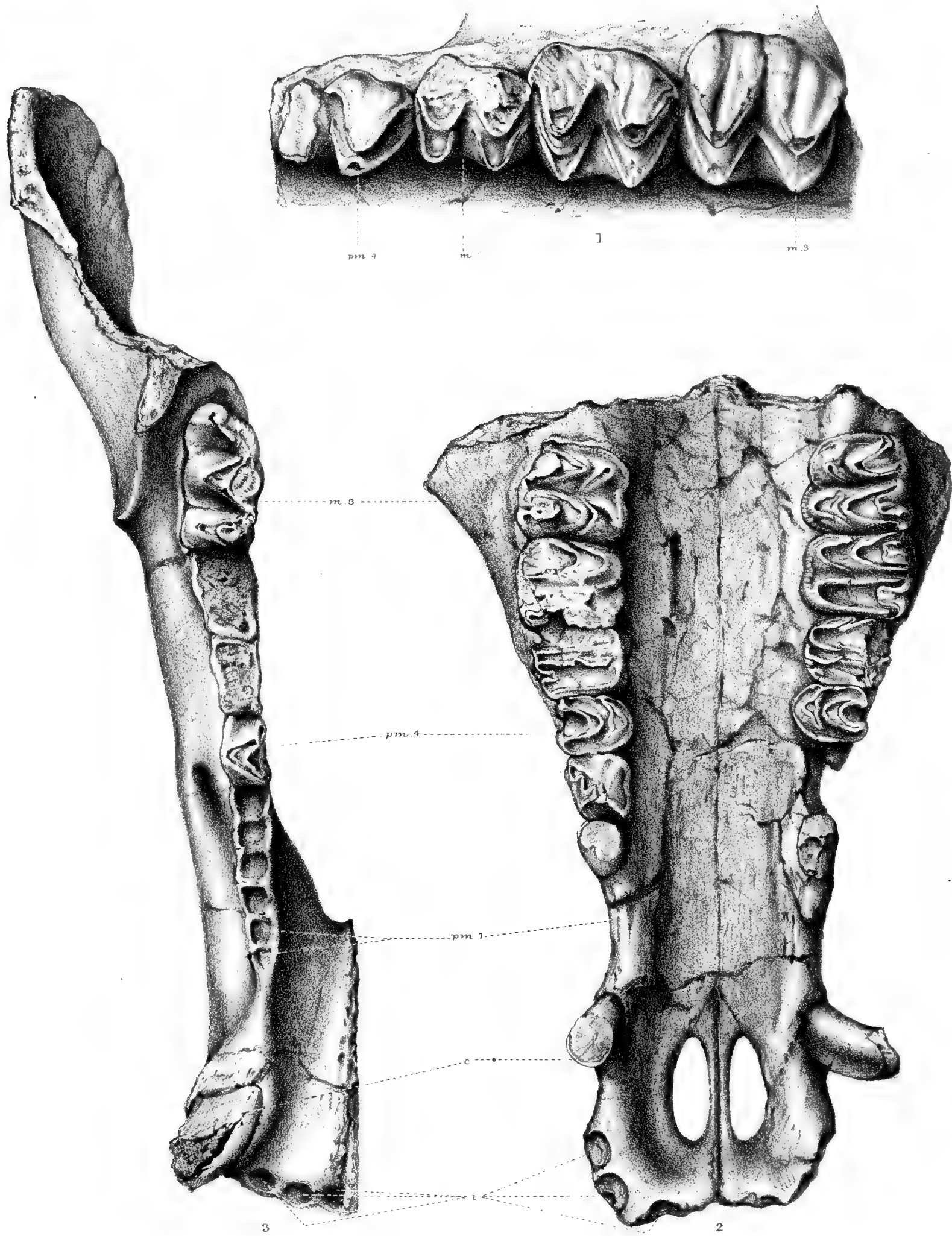
## PLATE V.

### ARTIODACTYLA — *Merycopotamidæ*.

- Fig. 1. MERYCOPOTAMUS DISSIMILIS, F. and C. The last four left upper cheek-teeth of a male ;  
from the Siwalik Hills. British Museum (No. 18411). *Page* 16.
- „ 2. MERYCOPOTAMUS DISSIMILIS, F. and C. The anterior portion of the cranium of a female ;  
from the Siwaliks of Bhimber, Jamu. Indian Museum (No. B. 110). *Page* 16.
- „ 3. MERYCOPOTAMUS DISSIMILIS, F. and C. The right ramus of the mandible of a male ;  
from the Siwalik Hills. British Museum (No. 18412). *Page* 17.

---

\* *Fig. 1, 1; figs. 2, 3, 3. In fig. 2 the teeth are viewed directly from the grinding surface, but in fig. 1 the view is taken obliquely in order to show the external surface.*









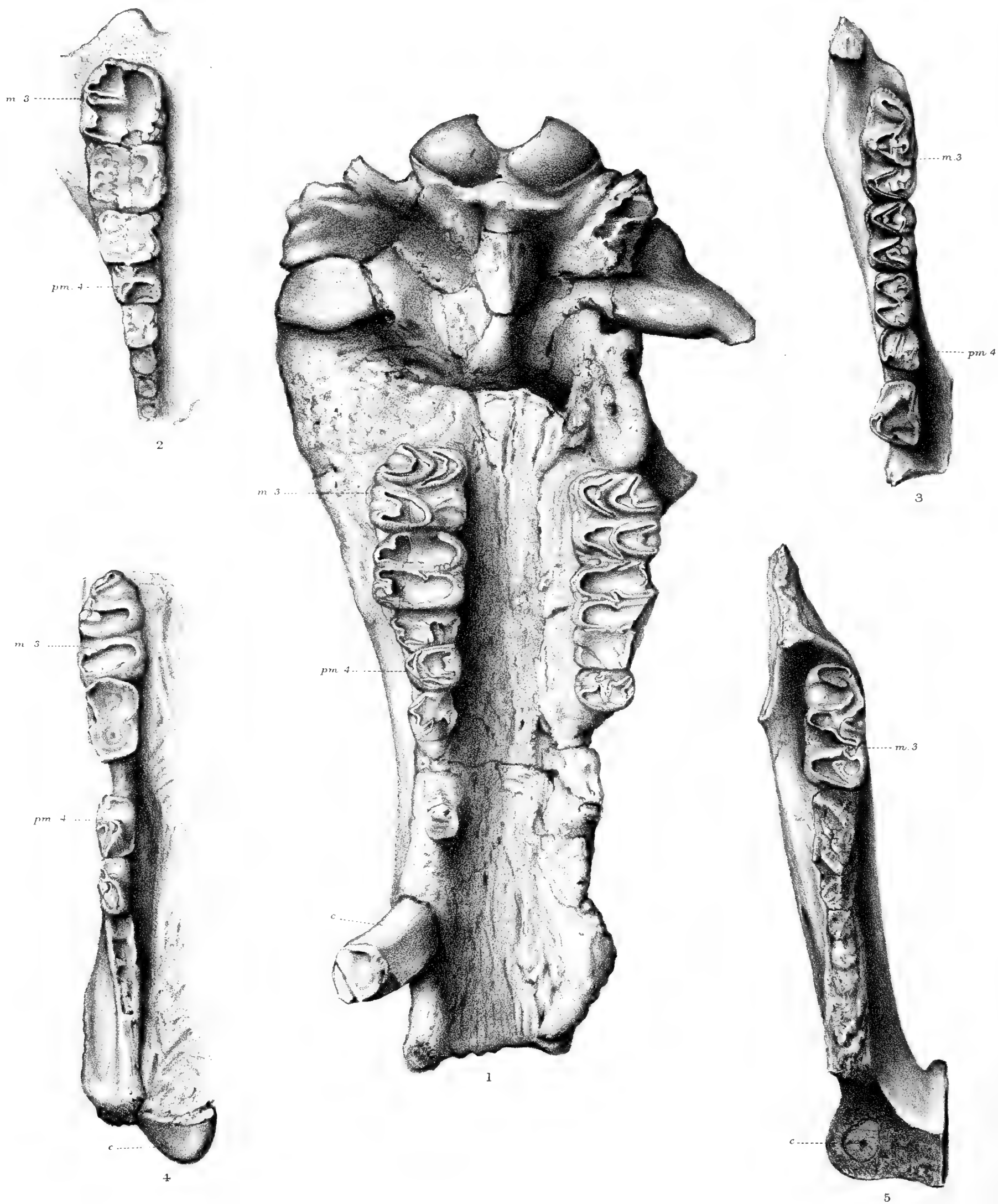
## PLATE VI.

### ARTIODACTYLA — *Merycopotamidæ*.

- Fig. 1. MERYCOPOTAMUS NANUS, Lyd. Cranium of a male; from the Siwalik Hills. British Museum (No. 16551). *Page* 17.
- „ 2. MERYCOPOTAMUS NANUS, Lyd. The worn left upper cheek-dentition of a female; from the Siwaliks of the Punjab. Indian Museum (No. B. 111). *Page* 18.
- „ 3. MERYCOPOTAMUS sp. Part of the right ramus of the mandible; from the Siwaliks of the Punjab. Indian Museum (No. B. 118). *Page* 17.
- „ 4. MERYCOPOTAMUS NANUS, Lyd. Greater part of the left ramus of the mandible of a male; from the Siwalik Hills. British Museum (No. 18407). *Page* 18.
- „ 5. MERYCOPOTAMUS NANUS, Lyd. Greater part of the right ramus of the mandible of a female: from the Siwalik Hills. British Museum (No. 15349). *Page* 18.

---

\* All the figures  $\frac{2}{3}$  nat. size.





MEMOIRS  
OF THE  
GEOLOGICAL SURVEY OF INDIA.

*Palæontologia Indica,*

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING  
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. X.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

Vol. IV.

Part II. THE FAUNA OF THE KARNUL CAVES.

*(And Addendum to part I.)*

By R. LYDEKKER, B.A., F.G.S., etc.

WITH 5 PLATES.

CALCUTTA.

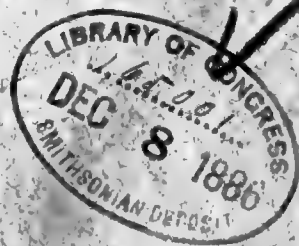
SOLD AT THE

GEOLOGICAL SURVEY OFFICE, AND BY ALL BOOKSELLERS.

LONDON. TRÜBNER & CO.

MDCCCLXXXVI.

PRINTED BY GIBBS AND BAMFORTH, ST. ALBANS, HERTS.



05756

I 4



MEMOIRS  
OF THE  
GEOLOGICAL SURVEY OF INDIA.

---

*Palæontologia Indica,*

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING  
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

---

Ser. X.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

Vol. IV.

Part II. THE FAUNA OF THE KARNUL CAVES.

By R. LYDEKKER, B.A., F.G.S., etc.

WITH 5 PLATES.

---

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE, AND BY ALL BOOKSELLERS.

LONDON: TRÜBNER & CO.

---

MDCCCLXXXVI.

---

PRINTED BY GIBBS AND BAMFORTH, ST. ALBANS, HERTS.



(Substitute for slip previously issued).

## CORRIGENDA.

- Vol II. p. ix. note 1, after 'Amer. Nat,' add 1880. The formmla of the cutting-teeth of the American rhinoceroses has been amended ; see "Cat. Foss. Mamm. Brit. Mus." pt. III. p. 141.
- „ 144, note 1, for Nat. read Géol. (The volume is dated 1882, although the article quoted. appeared in 1881).
- „ 145, „ 2, for Nat. read Géol., for VII. read VIII., and for 1878 read 1877. (In the reprint quoted the articles from the two vols. are paged consecutively).
- „ 148. The age of *Anthracotherium dalmatinum* is upper eocene.
- „ 154, note 2, for 143 read 103.
- „ 157. If the Hempstead group be reckoned as equivalent to the Ronzon beds the age of both *Hyopotamus bovinus* and *H. velaunus* will be lower miocene (mid. oligocene) only. For synonymy see "Cat. Foss. Mamm. Brit. Mus." pt. II.
- „ 164, line 11 from bottom, for 1839 read 1836.
- „ 169. *Sivameryx* is the same as *Chæromeryx*; vide 'Geol. Mag.,' vol. II., p. 73 (1885).
- „ 175, line 13 from top, for XIII. pl. V. read XII., art. 3.
- „ 176, „ 15 „ „ „ XIV. read XIX.
- „ 185, after *Mellivorodon palæindicus* add n. sp.
- „ 208. The relative lengths of the molars of *Ursus arctos* are not constant.
- „ 236, note 2, and 354, line 19 from top, add ser. 4 (1855).
- „ 314. The premolar dentition of *Felis* is  $\frac{(2-8)}{2}$ .
- „ 348, line 11 from bottom, for Laizier and Pariere, read Laizer and Parieu.

After *Hyopotamus palæindicus* (p. 158), *Hyænarctos palæindicus* (232), and *Ælurogale sivalensis* (317), dele n. sp., and after *Hemimeryx* (167) and *Sivameryx* (169) dele n. gen.

For amended nomenclature of non-Indian Mammalia mentioned in this volume see the writer's "Catalogue of Fossil Mammalia in the British Museum."

Vol. III. p. 237. The vertebra of *Python* described on this page and figured in pl. XXXV., figs. 7, 7a, as a caudal is a dorsal.



## ADDENDUM.

GENUS. TETRACEROS, Leach.<sup>1</sup>

*Distribution*.—The genus is represented at the present day only by *T. quadricornis*,<sup>2</sup> which occurs over the whole of India.

## TETRACEROS DAVIESI, n. sp. nobis.

*Definition*.—This species is slightly larger than *Cephalophus madoqua*, and distinguished from *T. quadricornis* by its inferior size, and the narrower anterior premolars.

*Cranium*.—In the course of a recent examination of the duplicate Siwalik collection in the British Museum, Mr. W. Davies brought to light the middle portion of the cranium of a small ruminant which he at once recognized as new, and kindly handed over to the writer for description. The specimen (woodcut fig. 3) comprises

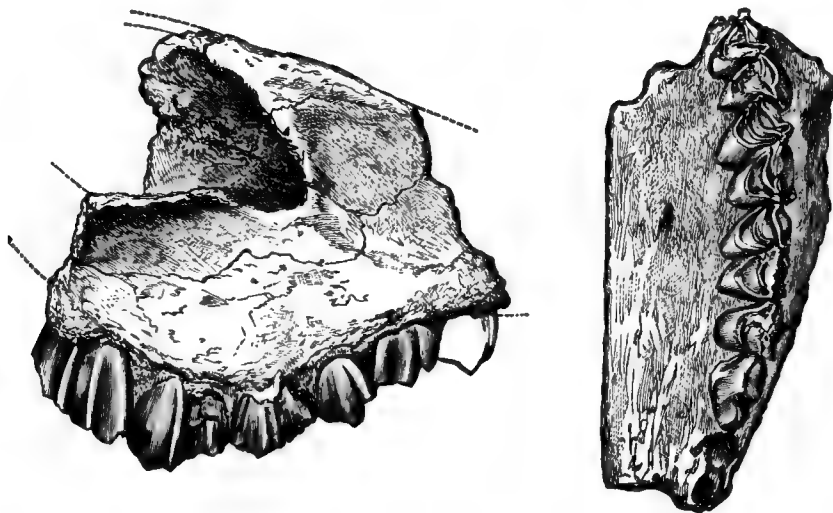


Fig. 3. *Tetraceros daviesi*, Lyd. The right half of the middle portion of the cranium and of the palate; from the Siwalik Hills. †. British Museum. (No. M. 3492).

the portion of the cranium between the middle of the orbit and the posterior extremity of the premaxilla, and indicates an animal slightly larger than the existing African *Cephalopus madoqua*, Gray; the whole of the palate and cheek-dentition is preserved, but the crowns of some of the teeth (which are in an early stage of wear) are either broken off, or more or less damaged. All the teeth have high crowns, and the true molars are relatively wide, and have no internal accessory column. The fourth premolar has a very strongly-marked anterior costa, and the superior border of its inner crescent is incomplete anteriorly; pm.3 is much elongated, narrow transversely, with a very incomplete inner crescent, and only a small inner root; the crown of pm.2 is broken off, but the section of its base shows that this tooth was very long and narrow, and had no inner root. The palate is narrow and

<sup>1</sup> 'Trans. Linn. Soc.' vol. xiv. p. 524 (1823).

<sup>2</sup> The so-called *T. quadricornutus* is only a variety.

concave, and the median notch on the posterior border extends as far forward as the anterior border of m.3. The fragment of the fronto-nasal region still remaining shows that in the neighbourhood of the orbit this portion was flattened and triangular, with a slight sulcus in advance of the small frontal foramen; there is a shallow lachrymal depression, of which the whole is visible from the frontal aspect of the cranium, but no lachrymal vacuity; there was no horn immediately above the orbit. The length of the series of cheek-teeth is 2.1, that of the true molars 2.1, and that of the premolars 1.04 inches.

*Mandible*.—The fragment of the right ramus of the mandible of a small ruminant from the Siwaliks represented in woodcut fig. 4 agrees in relative size with the cranium, and not improbably belongs to the same species. It contains the last two

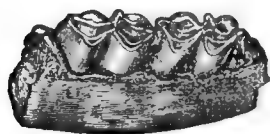


Fig. 4. (?) *Tetraceros daviesi*, Lyd.  
Fragment of the right ramus  
of the mandible; from the  
Siwalik Hills. British Museum  
(No. 16535).

lobes of mm.4, and the complete m.1; on the outer aspect of the latter there is seen the broken base of a slender accessory column, like that occurring in some examples of *Tetraceros quadricornis*.

*Affinities*.—The structure of the true molars shows that the only groups to which the cranium under consideration could belong are the *Tragulidæ*, the *Cervidæ*, or the antelopes. From the existing genera of the former<sup>1</sup> it is distinguished by the taller teeth, the presence of an inner crescent to pm.3, the form of the palate, and the presence of a lachrymal depression. That it does not belong to the smaller members of the second family, like *Cervulus* and *Moschus*, is evident from the hypsodont dentition, the elongation of pm.3, and the incompleteness of its inner crescent, together with the small size of the inner root of the latter and its total absence in pm.2; while the absence of a lachrymal vacuity, the concavity and narrowness of the palate, and the form of the fronto-nasal region are equally distinctive characters.

Among the smaller antelopes the specimen is at once distinguished from *Gazella*, *Nemorhædus*, *Neotragus*, *Nanotragus*,<sup>2</sup> and their allies by the squareness of the crowns of the true molars; but when compared with the group comprising the African genus *Cephalopus* and the Indian *Tetraceros* a close agreement is found in this respect. The smaller species of the former, like *C. madoqua*, agree nearly in size with the fossil, but are distinguished by the much deeper lachrymal depression, of which only a portion is visible from the frontal aspect, by the wider frontal region, and the greater anterior extent of the median palatine notch. The premolars are moreover less elongated, and have less incomplete inner crescents, while the outer surfaces of the true molars are much narrower. In the upper molars of the larger species of that genus, like *C. sylvicultrix*, there is a well-developed inner accessory column, while some of the smaller species show a projection from the hinder border of the anterior crescent in little-worn true molars, which is wanting in the fossil.

<sup>1</sup> In the genera *Prodremotherium* and *Bachitherium*, which have been provisionally referred to this family ("Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 150, 155), there is an imperfect inner crescent to pm.3. The molars are of a very brachydont structure.

<sup>2</sup> Including *Calotragus*, *Scopophorus*, *Nesotragus*, and *Oreotragus*; see Brooke 'Proc. Zool. Soc.' 1872. p. 642.

Turning now to *Tetraceros* and taking for comparison a female skull<sup>1</sup> of which the first four upper cheek-teeth are figured in the accompanying woodcut, it will be



Fig. 5. *Tetraceros quadricornis* (Blainv).  
The first four right upper cheek-teeth  
of a female, from the grinding and  
outer aspects. Recent, Madras. British  
Museum (No. 884a).

found that there is a very close resemblance in almost every particular. The general contour of the orbital and fronto-nasal region, of the palate, and of the lachrymal depression, is almost identical in the recent and fossil crania. The true molars of the recent form agree with those of the fossil in the breadth of their external lobes, and the absence of an inner accessory column;<sup>2</sup> while the premolar series of the former bears nearly the same relative proportion to the true molar series as obtains in the latter, and also shows the same incompleteness

of the inner crescents of pm.2 and pm.3; the length and narrowness of the two latter teeth is, however, rather less marked in the recent skull, and the anterior costa in pm.3 and pm.4 is somewhat less prominent, while there is a minute inner root to pm.2, and the lateral palatal notches are deeper than in the fossil. The length of the whole series of cheek-teeth in the recent cranium is 2.35 inches. The fragment of the mandible mentioned above agrees very closely with the lower jaw of the recent species, and, as already mentioned, exhibits the slender accessory external column characteristic of certain specimens of the latter.

As the result of the foregoing comparisons there appears no doubt that the cranium under consideration indicates an antelope so closely allied to the existing *Tetraceros*, that it may be pretty safely referred to the same genus; but whether the specimen indicates a female individual, or that the anterior horns (which are inconstant in the existing species) were not developed in the fossil form, cannot be determined. The inferior size of the latter and the characters of the premolars indicate its specific distinctness, and it may be appropriately named *T. daviesi*.

The present form is of considerable interest as exemplifying more fully than hitherto the remarkable mingling in the Siwaliks of genera now respectively confined to India and Africa. A fragment of the maxilla with the three true molars of a small Siwalik antelope in the British Museum (No. M. 3493) differs from the corresponding part of the cranium of *Tetraceros daviesi* by the narrower outer surfaces of the teeth, and may perhaps belong to a small species of *Cephalopus*.

<sup>1</sup> This specimen belongs to the variety specifically separated by Gray under the name of *T. subquadricornutus*; see 'Hand-list of Edentate, Thick-skinned, and Ruminant Mammals in British Museum,' p. 89. No. 884a (1873).

<sup>2</sup> This character is not a constant one, since the male crania of the type form in the British Museum exhibit a slender accessory column in the true molars; similar variations occur in the corresponding lower teeth.



### POSTSCRIPT.

It should have been observed that the reference of *Antilope torticornis*, Aymard, to *Palæoreas* is on the authority of M. P. Thomas ('Mém. Soc. Géol. France.' ser 3. vol. III. art. 2. p. 16), and that it is referred by M. Depéret in the passage quoted in the text to *Tragelaphus*. According to Prof. Rüttimeyer's description ('Die Rinder der Tertiär-Epoche, etc.' p. 85) the molars of this form are very similar to those of *Strepsiceros* (?) *falconeri*. Since the text was in type the writer has noticed that a tooth from the 'Bohnerzgruben' of Würtemberg has been described by Prof. Rüttimeyer (see p. 88 of the work cited) as *Hippotragus fraasi*. If this determination and the reference of *A. torticornis* to *Tragelaphus* rather than to *Palæoreas* be correct, there is evidence of the occurrence of two existing African genera of antelopes in the tertiaries of Europe.

# INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

---

## THE FAUNA OF THE KARNUL CAVES.

BY R. LYDEKKER, B.A., F.G.S., ETC.

(WITH PLATES VII. TO XI.)

---

### I. INTRODUCTORY OBSERVATIONS.

*Locality.*—The history of the exploration of the caves in the Karnul district of Madras is given in three papers by Mr. R. B. Foote,<sup>1</sup> and does not need recapitulation on this occasion. The most important of these caves are those of Billa Surgam, a spot lying on the south of a valley opening on the east of the Yerra Konda, a range of hills forming the western side of the Karnul basin, and situated three miles to the east-south-east of Betumcherru, in the south-eastern corner of the Nandial taluk; the nearest place of any importance being Banaganpalli.

*The caves.*—According to Mr. Foote's description, Billa Surgam consists of three deep and short 'cañons,' joined by natural arches; the various caves opening into the cañons at different levels, and the cañons themselves having once been caves also; in wet weather a stream flows through the cañons. The accompanying plan<sup>2</sup> will obviate the need of further description; it being only necessary to mention that the four main caves are those named the 'Charnel-House,' 'Purgatory,' the 'Cathedral,' and the 'Chapter-House.'

*Sections of cave-deposits.*—Two sections of the cave-deposits may be quoted from Mr. Foote's papers. The first is from the Charnel-House, and is as follows.

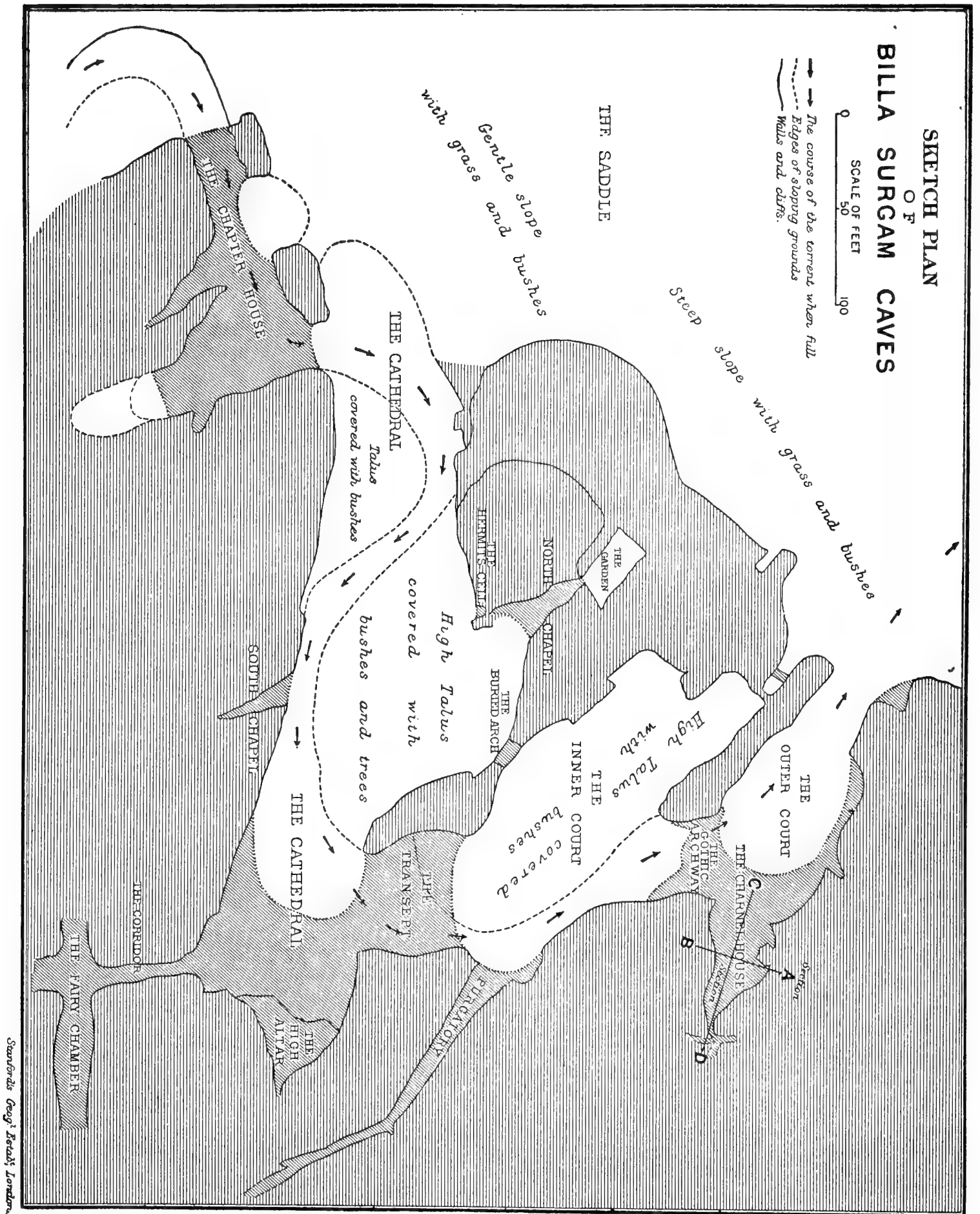
A1. Surface bed.

A. Rubble bed.

B. }  
C. } Stiff red clay, with sandy partings.

<sup>1</sup> 'Rec. Geol. Surv. Ind.' vol. XVII. pp. 27-34, 200-208 (1884), and vol. XVIII. pp. 227-234 (1885).

<sup>2</sup> The oblique-shading indicates the area of the existing caves.



- D. } Rubble bed.  
 E. }  
 H. Red cave-earth, stony above.  
 I. Red and mottled cave-earth.  
 J. Red-brown cave-earth with patches of calcareous sand.  
 K. } Red sandy cave-earth with blocks of limestone.  
 L. }  
 M. }  
 N. } Stiff marly clay.  
 O. }  
 P. }

In this section bed A1 is of extremely recent origin, and may be neglected; human teeth were found in bed A, pottery occurred in B. C., and Mr. Foote<sup>1</sup> records implements from K and L.

The second section is in the Cathedral, and is as follows.

- C. Surface bed.  
 C. Grey sandy bed.  
 Stalagmite in irregular masses.  
 Ca. Red sandy cave-earth.  
 Cb. }  
 Cc. } Stiff red clay.  
 Cd. }  
 Ce. } Stiff dark marl.  
 Cf. }  
 Ch. Dark loamy marl.  
 Ci. } Grey marl.  
 Cj. }  
 Ck. } Grey marl.  
 Cl. }

In this section the beds Cc. and Cd. yielded the most important specimens.

*Condition of the bones.*—The majority of the bones and many of the teeth are stained of a full brown colour, and strongly impregnated with mineral matter. Other specimens, however, which were obtained from beds containing extinct species, are scarcely altered, and are almost indistinguishable from the bones of recent animals; and since these specimens belong to fossorial rodents and carnivores it is pretty evident that they are of later age than the highly mineralized specimens with which they are associated.

The teeth of *Rhinoceros* from bed Cc. in the Cathedral are but little altered; and many of the incisors of *Hystrix* and other rodents from bed Cd. still retain their original orange colour. Of the larger mammals no complete skulls were found, the majority of the remains consisting either of detached teeth, fragments of the jaws, or more or less imperfect limb-bones. Of the smaller mammals skulls were found in some instances; but in many cases the only determinable remains are fragments of the jaws and limb-bones. Vast quantities of bones of Chiroptera and small Rodentia—probably introduced, as Mr. Foote suggests, by owls—were obtained in many of the beds, but these are totally valueless as not being even generically determinable. A considerable number of the larger bones have been gnawed by porcupines.

<sup>1</sup> 'Rec. Geol. Surv. Ind.' vol. XVII. p. 206.

*Age of the fauna.*—The comparatively large number of species either totally extinct, or which are not now found living in India, renders it probable that the age of a considerable part of the Karnul cave deposits is not newer than the pleistocene; and the fauna, as being almost certainly more recent than that of the Narbada beds, may be provisionally assigned to the later part of that period.

## II. MAMMALIA.

*List of species.*—Three preliminary and provisional lists of the Karnul mammals have been already published—two by Mr. Foote,<sup>1</sup> and one by the present writer.<sup>2</sup> The following list gives the result of the final determinations, but there is no evidence that *Mus platythrix*, and *Golunda ellioti* are contemporaries of the extinct forms.

PRIMATES. —	Semnopithecus entellus ( <i>Dufresne</i> ).	RODENTIA.—	Golunda ellioti, <i>Gray</i> .
	Cynocephalus, <i>sp.</i>		Hystrix crassidens, <i>nobis</i> .
CARNIVORA. —	Felis tigris ( <i>or ? leo</i> ) <i>Linn.</i>		Atherura karnuliensis, <i>nobis</i> .
	(?) pardus, <i>Linn.</i>		Lepus ( <i>cf. nigricollis</i> , <i>F. Cuv.</i> )
	chaus, <i>Güldenst.</i>	UNGULATA.—	Equus asinus, <i>Linn.</i>
	rubiginosa, <i>Geoffr.</i>		<i>sp. a.</i>
	Hyæna crocuta ( <i>Erxl.</i> )		Rhinoceros karnuliensis, <i>nobis</i> .
	Viverra karnuliensis, <i>nobis</i> .		Bos <i>or</i> Bubalus, <i>sp.</i>
	Prionodon (?), <i>sp.</i>		Boselaphus tragocamelus ( <i>Pall.</i> )
	Herpestes griseus, <i>Desm.</i>		<i>Genus non. det.</i>
	fuscus, <i>Waterh.</i>		Gazella bennetti ( <i>Sykes</i> ).
	Ursus labiatus, <i>Blainv.</i>		Antilope cervicapra ( <i>Linn.</i> )
INSECTIVORA.—	Sorex, <i>sp.</i>		Tetracerus quadricornis ( <i>Blainv.</i> )
CHIROPTERA.—	Taphozous saccolæmus, <i>Temm.</i>		Cervus aristotelis, <i>Cuv.</i>
	Phyllorhina diadema ( <i>Geoffr.</i> )		axis, <i>Erxl.</i>
RODENTIA. —	Sciurus macrurus, <i>Hardw.</i>	(?)	Cervulus muntjac ( <i>Zimm.</i> )
	Gerbillus indicus ( <i>Hardw.</i> )		Tragulus ( <i>cf. meminna</i> [ <i>Erxl.</i> ])
	Nesokia bandicoota ( <i>Bech.</i> )		Sus cristatus, <i>Wagner</i> .
	kok, <i>Gray</i> .		karnuliensis, <i>nobis</i> .
	Mus mettada ( <i>Gray</i> ).	EDENTATA.—	Manis gigantea, <i>Illiger</i> .
	platythrix, <i>Sykes</i> .		
	<i>sp. var.</i>		

*Relations.*—The most remarkable feature in this list is the occurrence among a number of existing Indian species of a *Cynocephalus* which may be identical with a living African species, of *Hyæna crocuta*, of a small *Equus* indistinguishable from *E. asinus*, and of a *Manis* apparently identical with the existing west African *M. gigantea*;<sup>3</sup> while scarcely less noteworthy is the occurrence of a peculiar species of *Rhinoceros*, and of a *Hystrix* and a *Viverra* specifically distinct from the species now living in India, as well as of the non-Indian genus *Atherura*. The occurrence of the genus *Cynocephalus* and of forms identical with African species of *Hyæna*

<sup>1</sup> 'Rec. Geo. Surv. Ind.' vol. XVII. p. 202. XVIII. p. 231.

<sup>2</sup> *Ibid.* vol. XVIII. pp. 120-121.

<sup>3</sup> The importance of the occurrence of these forms would not be diminished even if it should ever be discovered that some of them present slight differences from their existing African representatives which might entitle them to specific distinction.

*Equus* and *Manis* is extremely important in supplementing the evidence afforded by the Siwalik fauna as to the probable derivation of many of the existing Ethiopian mammals from those of the later tertiaries of India; and it is interesting to trace the gradual dying out in the latter country of genera and species which are now dominant forms in Africa. In many instances such forms have totally disappeared, while in others the modern Indian representatives are either few in respect of individuals or inferior in size to their tertiary congeners. Thus *Cynocephalus* was represented by two species in the Siwaliks,<sup>1</sup> persisted to the pleistocene, and then finally disappeared. Similarly the crocutine group of *Hyæna* is represented in the Siwaliks by *H. felina* and *H. colvini*, and in the pleistocene by *H. crocuta* (which was probably the descendant of *H. colvini*), after which period the group entirely died out in India. Again in the case of the edentates we find the gigantic Siwalik *Macrotherium sindiense*,<sup>2</sup> which presents features connecting it with *Manis*, succeeded by the smaller *Manis gigantea* of Karnul, which has now migrated to Africa, while all the species of the latter genus now inhabiting peninsular India are of greatly inferior size. *Atherura* offers an instance of a genus now totally unrepresented in India proper but occurring in Africa, and also in the east of the Oriental region. The lion, which is known to occur in the pleistocene of Europe and probably existed at the same date in India, may be cited as an analogous instance, since it is a comparatively rare animal in the latter country, although very abundant in Africa. *Equus* again, though still poorly represented in the north-west of India, has entirely died out as a wild genus in the greater part of the country, but has attained a great development in Africa. Still more striking examples are to be found in the total disappearance from India of *Hippopotamus*, *Giraffa*, and *Alcelaphus* and other antelopes of modern African genera.<sup>3</sup> There is at present no satisfactory explanation of this total extinction in India of genera and species which appear equally as well suited to exist there at the present day as those which remain.<sup>4</sup> On the other hand *Felis chaus* may be cited as an example of a species which probably originated in India, and is still common there, although having extended its range to northern Africa.

The *Viverra* and *Hystrix* of Karnul are probably the progenitors of the existing Indian species and the descendants of the Siwalik representatives of those genera; while it is also probable that the existing *Sus cristatus* was derived from the Siwalik *S. falconeri*, from which may also have originated the extinct *S. karnuliensis*. The extension of this group of pigs into the pliocene of Africa is indicated by *S. phacochæroides*. The Karnul *Rhinoceros* and the other pleistocene Madras species (*R. deccanensis*) belong to the less specialized section of the atelodine group,<sup>5</sup> of which there is no representative either in pliocene<sup>6</sup> or recent India. The former range of the existing *R. unicornis* into Madras is noticed in the sequel.

<sup>1</sup> *Vide supra*, pp. 6-7.

<sup>2</sup> Syn. *Manis sindiensis*, *vide infra*.

<sup>3</sup> *Vide supra*, pp. 7-15.

<sup>4</sup> The glacial epoch can scarcely be brought forward in the case of southern India.

<sup>5</sup> Comprising *R. bicornis* and all the European pleistocene species except *R. antiquitatis*. See "Cat. Foss. Mamm. Brit. Mus." pt. III. pp. 101-123. (1885).

<sup>6</sup> *R. platyrhinus* belongs to the more specialized section.

*Specimens figured.*—With the exception of some of the smaller rodents, of which the pleistocene age is doubtful, remains of nearly all the Karnul mammals are figured in the accompanying plates and woodcuts; the figured specimens generally comprising more or less incomplete crania, mandibles, or teeth. Of limb-bones, specimens of the humerus, and more rarely the femur, of a considerable number of genera have been figured, as it has been thought such figures may be useful to future explorers of Indian caverns and aid them to identify some of the commoner forms with which they may expect to meet.

SEMNOPIITHECUS ENTELLUS (Dufresne): *var.*

*Maxilla and mandible.*—In the writer's preliminary notice the remains of this form were referred, after Mr. Foote's provisional determination, to *S. priamus*, but subsequent examination has shown that they are too large for that species. The fragments of an associated right maxilla and mandibular ramus represented in plate VII., figs. 2, 3 were obtained from bed *M.* of the Charnel-House,<sup>1</sup> and exhibit the teeth in an early condition of wear; the inferior portion of the mandible has been crushed and bent on one side. The teeth of these specimens are rather larger than those of any specimen of *S. entellus* in the British Museum, and agree in this respect with the Himalayan *S. schistaceus*;<sup>2</sup> it is, however, practically certain that they do not belong to the latter, and they may accordingly be provisionally regarded as belonging to a large variety of the former. In the upper jaw the length of the space occupied by the three true molars is 1.1, and in the lower 1.22 inches. The specimen represented in fig. 1 of the same plate comprises the greater part of the right half of the palate, and shows all the teeth except *i.1* and *m.3*; it was obtained from bed *A.* in the Charnel-House,<sup>3</sup> and from the small size of the canine evidently belonged to a female; the cheek-teeth agree in size with those of the preceding specimens. Two canines (No. F. 200) belonging to male individuals have been obtained from beds *Cc.* and *Ce.* in the Cathedral, and numerous detached cheek-teeth from other beds.

*Calcaneum.*—The right calcaneum represented in plate VII. fig. 4 was obtained from bed *C.* in the Cathedral, and agrees in relative size with the teeth. An associated right calcaneum and astragalus (No. F. 201,c) from the Purgatory cave may belong to an immature individual of the present species, or may indicate the occurrence of a second form.

*Horizon and range.*—The present form appears to have existed during the whole period of the Karnul cave deposits. There appears some uncertainty as to the southern limit of the range of the existing race, but it is probable that it embraces at least a portion of the Deccan.<sup>4</sup>

CYNOCEPHALUS, sp.

*Lower molar.*—The unworn second left lower true molar of a large monkey

<sup>1</sup> See Foote 'Rec. Geol. Surv. Ind.' vol. XVII. p. 207.

<sup>2</sup> Compare the mandible represented in pl. I. fig. 6. of the preceding part of this volume.

<sup>3</sup> See Foote, *op. cit.* p. 206.

<sup>4</sup> See Jerdon, 'Mammals of India,' pp. 5, 6.



represented in pl. VII. figs. 5, 5a was obtained from bed *M.* in the Charnel-House.<sup>1</sup> In its very large size, tall crown, and form of the cusps, this specimen differs widely from the teeth of *Semnopithecus* and *Macacus*, and agrees so exactly with those of *Cynocephalus* that there can be no doubt as to its belonging to that genus.

*Affinities.*—The specimen accords very closely with the corresponding tooth of the existing *C. anubis*, but as it might apparently have equally well belonged to the Siwalik *C. falconeri*,<sup>2</sup> it appears impossible to make any specific determination. The intimate relationship existing between some of the Karnul mammals and those of Africa suggests, however, that the present form may be more nearly allied to the existing species of that country than to those of the pliocene of India.

#### FELIS TIGRIS (or ? LEO), Linn.

*Limb-bones.*—Since it appears impossible to distinguish the limb-bones of the tiger from those of the lion it is by no means certain, in view of the occurrence of *Hyæna crocuta* in the Karnul caves, that at least some of the under-mentioned specimens may not belong to the latter rather than to the former species.<sup>3</sup> The first phalangeal of the third digit of the right pes represented in pl. VII. fig. 20 was found in association with a first and second lateral phalangeal, the fragment of a metatarsal, and the greater portion of the tibia of the same side, in the Purgatory cave.<sup>4</sup> These specimens indicate an individual equal in size to a large tiger. Another first phalangeal (No. F. 224,b) was obtained from bed *Cf.* of the Cathedral.

*Carnassial.*<sup>5</sup>—The anterior portion of the outer half of a left upper carnassial (No. F. 224) apparently agreeing with that of the tiger was obtained from bed *Ce.* in the Cathedral.

#### (?) FELIS PARDUS, Linn.

*Limb-bones.*—The only evidence for the existence of this species in the Karnul cave-deposits is afforded by the first phalangeal represented in pl. VII. fig. 19, which was obtained from bed *Cc.* in the Cathedral, and by a metacarpal (No. F. 225,a) from bed *C.* in the same cave. These specimens are, however, of comparatively small size and can hardly be regarded as conclusive evidence.

#### FELIS CHAUS, Gldenstdt.

*Mandible.*—This cat is represented by the imperfect left mandibular ramus figured in pl. VII. fig. 17, which was obtained from bed *Ca.* in the Cathedral. The carnassial has been broken, but the two premolars are perfect, and the posterior half of the alveolus of the canine still remains.

<sup>1</sup> This is apparently the specimen noticed by Foote in the 'Rec. Geol. Surv. Ind.' vol. XVII. p. 207, and regarded as belonging to the same species as the *Semnopithecus*.

<sup>2</sup> *Supra.* pl. I. fig. 4.     <sup>3</sup> Jerdon, "Mammals of India," p. 92. mentions the occurrence of the lion south of the Narbada.

<sup>4</sup> See Foote, 'Rec. Geol. Surv. Ind.' vol. XVII. p. 207.

<sup>5</sup> Mr. Foote *op. cit.* mentions an upper carnassial rather smaller than that of a tiger, but the writer was unable to identify the specimen in the collection.

*Canine*.—The left upper canine<sup>1</sup> represented in fig. 18 of the same plate exhibits on its outer surface<sup>2</sup> the grooves characteristic of the genus, and from its size may be referred to the present species.

*Distribution*.—This species occurs at the present day throughout India, and to the eastward ranges into Assam and Burma, and to the westward into Persia, the borders of the Caspian, and north Africa. Its occurrence in the pleistocene of India points to the probability of that country having been its original home.

FELIS RUBIGINOSA, Geoffr.

*Maxilla and mandible*.—This very small cat, which is peculiar to Madras and Ceylon, is represented by four specimens in the Karnul collection. The imperfect left maxilla figured in pl. VII. figs. 14, 14a shows pm.3 and pm.4, and the alveoli of the canine and m.1, and also exhibits the characteristic absence of pm.2. This specimen was obtained from bed *Ca.* of the Cathedral. The slightly imperfect right mandibular ramus represented in fig. 15 of the same plate was obtained from bed *Cb.* of the latter cave; and the collection also contains a less perfect specimen of the same side from bed *Ca.*

*Humerus*.—The right humerus represented in fig. 16 of the above-mentioned plate was found in bed *Cc.* of the Cathedral. The specimen has lost the head and part of the lateral expansion of the entepicondyle (*en. c*); it exhibits the well-marked entepicondylar foramen (*cf.*) and the absence of a supracondylar perforation, which are characteristic features of the humerus of *Felis* as distinguished from that of *Viverra*<sup>3</sup> and *Herpestes*, and since it agrees in relative size with the jaws it may be pretty safely referred to the present species.

HYÆNA CROCUTA (Erxleben).

*Carnassial*.—The partially-worn left lower carnassial of a hyæna represented in pl. VII. figs. 13, 13a was obtained from bed *Ce.* in the Cathedral, and agrees precisely with the corresponding tooth of the present species. It is somewhat smaller than is usually the case with the pleistocene European race of the species<sup>4</sup> (although some examples of the latter are scarcely larger<sup>5</sup>), and agrees more nearly in this respect with the existing African race. The characteristic features of the lower carnassial of this species are the total absence of an inner cusp, the very small size of the hind talon, and the frequent presence of a small cingulum on the external aspect of the anterior half of the blade; this cingulum being well-developed in the present specimen. The lower carnassials of the Siwalik *H. felina*<sup>6</sup> and *H. colvini*<sup>7</sup> are mainly distinguished from the corresponding tooth of *H. crocuta* by the decidedly larger

<sup>1</sup> The writer could not determine from which cave this specimen was obtained; it is marked *Pop.*

<sup>2</sup> The inner surface is shown in the figure.

<sup>3</sup> The perforation is absent in *Genetta* and *Paradoxurus*, but the humerus of the latter is distinguished by the great width of the distal expansion.

<sup>4</sup> Compare Gaudry, "Histoire des Temps Quaternaires," pl. IV. fig. 9. (1876).

<sup>5</sup> *Ibid.* pl. I. fig. 1.

<sup>6</sup> *Supra.* vol. II. pl. XXXVIII. fig. 1.

<sup>7</sup> *Ibid.* fig. 3.

hind talon; the cingulum is, however, absent in the first, although well-developed in the second Siwalik species, being in some instances<sup>1</sup> considerably larger than in the existing one.

*Canine*.—An imperfect upper canine (No. F. 223) from bed *Ce* in the Cathedral may not improbably be referred to the present species.

*Origin of the species*.—The occurrence of *H. crocuta* in the Karnul caves is of extreme importance in regard to the history of the species, since it connects its distributional area with that of the primitive crocutine Siwalik hyænas, and leaves but little doubt that the species originated in India from *H. colvini* and thence spread westward into Europe at the close of the pliocene or commencement of the pleistocene epoch<sup>2</sup> (when it attained its largest dimensions), and subsequently reached Africa. The strongly-marked cingulum in the Karnul carnassial is especially noteworthy as indicating the close connection of this race with *H. colvini* rather than with *H. felina*.

VIVERRA KARNULIENSIS, *nobis*.<sup>3</sup>

*Definition*.—The species may be defined as equal in size to *V. zibetha*, but distinguished by the much longer space occupied by the premolar series, in which respect it appears allied to the Siwalik *V. bakeri*.

*Mandible*.—The type specimen of this species was obtained from bed *L* in the Charnel-House,<sup>4</sup> and is represented in pl. VII. figs. 6, 6a. The specimen consists of a fragment of the alveolar portion of the left ramus of the mandible showing the alveoli of all the premolars except  $\overline{pm.1}$ , and the complete  $\overline{m.1}$  in a partially-worn condition. The latter tooth agrees very closely, both in size and structure, with the carnassial of *Viverra zibetha*; almost the only observable difference being that the crown is relatively rather wider, more especially in its talon half. The premolar alveoli, as will be seen by the measurements, occupy, however, a much longer space, and the ramus when complete was evidently much deeper. In the following table the dimensions of the specimen are compared with those of the mandible of *V. zibetha*.

	<i>V. karnuliensis.</i>	<i>V. zibetha.</i>
Length of $\overline{m.1}$ . . . . .	0.59	0.6
Width of do. at mandible . . . . .	0.3	0.3
Length of space occupied by alveoli of last three premolars . . . . .	1.28	1.08

*Affinities*.—*Viverra megaspila* agrees so closely with *V. zibetha* that what applies in one case applies in the other, and the lower carnassial of *V. civetta* is quite different from that of the fossil. None of the larger existing species of *Herpestes* agree with the latter, so that its distinctness from all living species may be taken for granted. Of the Siwalik species *V. bakeri*<sup>5</sup> (of which the mandible is unfortunately unknown) agrees with the present form in relative size, as well as in the important character of  $\overline{pm.3}$  being longer than in the existing species.<sup>6</sup> This probably indicates

<sup>1</sup> *Supra*. vol. II. p. 296. fig. 14.    <sup>2</sup> It occurs in the Norfolk Forest bed.    <sup>3</sup> 'Rec. Geol. Surv. Ind.' vol. XIX. p. 120 (1886).

<sup>4</sup> See Foote 'Rec. Geol. Surv. Ind.' vol. XVII. p. 206.

<sup>5</sup> *Supra*. vol. II. pl. XXXIII. fig. 1.

<sup>6</sup> *Ibid.* p. 270.

that the Karnul civet is allied to this species, although the distinctness of the other Karnul mammals from those of the Siwaliks renders it unlikely that it is specifically the same. Compared with *Ictitherium* the fossil agrees nearly in size with *I. robustum*,<sup>1</sup> and approaches it in the depth of jaw and elongation of the premolars, but differs by the blade of the carnassial being longer in proportion to the talon. Since the two Siwalik species decidedly belong to *Viverra*<sup>2</sup> and not to *Ictitherium*, it appears most probable that the Karnul form should likewise be referred to the existing genus. The Karnul mandible indicates, however, that the three extinct Indian species (like *V. pepraxti*, Depéret,<sup>3</sup> of the lower pliocene of France) were probably intermediate between *V. zibetha* and *I. robustum*; and it is also probable that the origin of the existing specialized Indian species may be traced directly through *V. karnuliensis* to the Siwalik *V. bakeri*.<sup>4</sup> The apparent occurrence of *Viverra*<sup>5</sup> in the upper eocene (oligocene) of England indicates that the genus is an old one, and *Ictitherium* must probably, therefore, be regarded as an offshoot from one of the later species which has assumed characters almost precisely intermediate between the less specialized species of *Viverra* and *Hyaena*.

PRIONODON (?), sp.

*Humerus*.—The imperfect left humerus of a small carnivore represented in pl. VII. fig. 12 was obtained from bed *Cb* in the Cathedral, and may probably be referred to the *Viverridae*. It indicates a species agreeing approximately in size with *Herpestes griseus* (fig. 9), but differs from the humerus of that genus by the absence of the supracondylar perforation and the smaller lateral expansion of the entepicondyle (*en.c.*).<sup>6</sup> It agrees in these points with *Prionodon*, and its resemblance to the corresponding bone of the Nipalese *P. pardicolor* is so close as to indicate the probability of its belonging to the same genus, although it is of considerably larger size than the corresponding bone of that species, and would probably, therefore, agree more nearly with *P. maculosus* of Darjiling, Tenasserim, etc. The African genus *Poiana* is, however, very closely allied to *Prionodon*,<sup>7</sup> and since the writer is not aware that the limb-bones of the two can be distinguished, the reference of the present specimen to *Prionodon* must be regarded as purely provisional; to whatever genus it really belongs the specimen is important as indicating a form apparently different from any now found in Madras.

HERPESTES GRISEUS (Desmarest).

*Skull*.—The slightly imperfect cranium and left mandibular ramus represented in pl. VII. figs. 7, 8 were obtained, in association with a considerable portion of the

<sup>1</sup> See Gaudry, "Animaux Fossiles et Géologie de l'Attique," pl. VII.

<sup>2</sup> This is shown by the shorter *pm. 3* and larger *m. 1* and *m. 2*.

<sup>3</sup> Thèses. Facult. Sci. Paris. sér. A. No. 67. (Bassin Tertiaire du Rousillon) p. 137. pl. IV. figs. 1-6 (1885).

<sup>4</sup> *Supra*. vol. II. p. 271. <sup>5</sup> *V. hastingiae*, Davies. See Lyd. "Cat. Foss. Mamm. Brit. Mus." pt. I. p. 101. figs. 11-12.

<sup>6</sup> The humerus of *Paradoxurus* is distinguished by its wide distal expansion. In *Mustela* the humerus has no supracondylar perforation, but in *M. flavigula* that bone is much larger and its distal extremity relatively wider than the present specimen, while in the smaller species of that genus the whole bone is considerably smaller.

<sup>7</sup> See Mivart, 'Proc. Zool. Soc.' 1882. p. 159.

appendicular skeleton, from bed *Ch* in the Cathedral; they are remarkable for their extremely fresh and unaltered appearance, from which circumstance, together with the fossorial habits of the species, it is probable that they are of later age than the bed in which they occur. A left mandibular ramus without teeth (No. F. 230,b) in a more mineralized condition from bed *Ca* in the same cave, and another belonging to the right side from the Purgatory cave (No. F. 230,c) may be apparently referred to the same species, and indicate its existence among the proper cave fauna.

*Humerus*.—A left humerus from bed *Ca* in the Cathedral is represented in fig. 9 of the same plate. This specimen is slightly smaller than the corresponding bone associated with the skull, but the difference is probably merely an individual one. Other specimens exhibit slight variations in both directions from the figured specimens, and it is not improbable that some of the larger ones may belong to *H. smithi*.

#### HESPESTES FUSCUS, Waterhouse.

*Mandible*.—Of this small species, which occurs in Madras and Ceylon,<sup>1</sup> two mandibular rami have been obtained from bed *Cd* in the Cathedral, of which the most perfect is represented in pl. VII. figs. 10, 10a. The figured specimen, which has lost all the teeth with the exception of  $\overline{pm.4}$  and  $\overline{m.1}$ , agrees precisely with the mandible of the existing form.

*Humerus*.—The left humerus represented in fig. 11 of the same plate is one of several specimens agreeing in relative size with the mandible, which are accordingly referred to the same species. These specimens were obtained from beds *Ca* and *Cb* of the Cathedral cave.

#### URSUS LABIATUS,<sup>2</sup> Blainville.

Syn. *Melursus ursinus* (Shaw).

*Humerus*.—The imperfect distal extremity of a right humerus of this species represented from the palmar aspect in pl. VII. fig. 21 was obtained from the Chapter-House cave in a bed numbered *Ab*.<sup>3</sup> This specimen, which has lost the greater portion of the entepicondyle (*en.c.*), agrees so exactly with the humerus of the existing form that there can be no reasonable doubt as to its specific identity.<sup>4</sup>

*Distribution*.—The species is spread over all southern and central India, and is probably descended from the Siwalik *U. theobaldi*.<sup>5</sup>

#### SOREX, sp.

*Crania*.—The superficial layers of the caves have yielded several crania of shrews, measuring 1.1 inches in length, which probably belong<sup>6</sup> to *S. serpentarius*, Geoffroy, and it was at first thought that three imperfect crania from bed *Ca* in the Cathedral

<sup>1</sup> The Ceylon form has been separated by some writers as *H. macarthiae*.

<sup>2</sup> The reasons for adopting this name will be found in vol. II. p. 207.

<sup>3</sup> Mr. Foote has not published a section of the beds in this cave.

<sup>4</sup> It was suggested in the preliminary list that the specimen might perhaps belong to *U. malayanus* or *U. namadicus*.

<sup>5</sup> *Supra*. vol. II. p. 211.

<sup>6</sup> In the preliminary list these specimens were provisionally referred to *S. cærulescens*.

and bed X in the Charnel-House were specifically identical. A subsequent examination of these specimens has, however, shown that they are of considerably smaller size; but the extreme difficulty of distinguishing the crania of the members of this genus renders it unsafe to attempt their specific determination. The well-marked hook to the first incisor indicates, however, that the specimens belong to *Sorex* proper.

TAPHOZOUS SACCOLÆMUS, Temminck.

*Skulls*.—Three imperfect crania and several fragments of the mandible of this species were obtained from beds C and Ci in the Cathedral, and also from the Charnel-House. The most perfect example of the cranium, which was obtained from bed Ci in the former cave, is represented in pl. VIII. figs. 10, 10a; the characteristic elongated postorbital process of the frontal is well shown in fig. 10, while the enlarged view of the cheek-teeth in fig. 10a exhibits the three true molars, the large pm.4, and the minute preceding premolar.

*Distribution*.—The species is found over a considerable part of India, and also in Ceylon, Burma, the Malay Peninsula, Sumatra, and Java.

PHYLLORHINA DIADEMA (Geoffroy).

*Skull*.—Of this widely distributed species imperfect crania and mandibular rami are comparatively common in both the Cathedral and the Charnel-House caves. The middle portion of a cranium from the latter cave is represented in pl. VIII. fig. 11, and the cheek-dentition of another specimen from bed Ch in the Cathedral in fig. 11a. The upper cheek-dentition of this species is numerically the same as in *Taphozous*, but the penultimate premolar is placed more externally, and the inner borders of the true molars are more rounded; there is no supraorbital process to the frontal. A left mandibular ramus from bed Ci in the Cathedral, in which the anterior teeth are wanting, is represented in fig. 12 of the same plate; and there are numerous similar specimens from the Charnel-House.

*Humerus*.—The right humerus from bed Ci in the Cathedral represented in pl. VIII. figs. 9, 9a may probably be referred to the present species. There are other similar specimens in the collection.

SCIURUS MACRURUS, Hardwicke.

*Mandible*.—The fragment of the left mandibular ramus of a squirrel represented in pl. VIII. fig. 5, which was obtained from bed Ca in the Cathedral and contains the partially worn m.1, agrees so closely with the mandible of *S. macrurus*, now inhabiting Madras, that it may be pretty safely referred to that species.

GERBILLUS INDICUS (Hardwicke).

*Mandible*.—This species is represented by several mandibular rami from the Cathedral and Charnel-House caves. The mineral condition of these specimens indicates that they are of the same age as the other fossils with which they are



associated. The specimen represented in woodcut fig. 1 A is from bed *Ca* in the Cathedral, and belongs to a fully adult male, the molars being well worn. The



Fig. 1. *Gerbillus indicus*. The left ramus of the mandible ( $\frac{1}{2}$ ) and grinding surface of the lower molars ( $\frac{3}{4}$ ). A. belongs to an adult male and is from bed *Ca* in the Cathedral; while B. belongs to an immature female, and is from bed X in the Charnel-House. (Indian Museum, No. F. 338).

smaller specimen represented in fig. 1 B has the molars much less worn, and may probably be referred to an immature female; it was obtained from bed X in the Charnel-House. The length of the space occupied by the three molars in this specimen is 0.24 inch, against 0.28 in the larger example;<sup>1</sup> the size of the teeth in the former being not greater than in *G. hurrianæ* of north India and Persia. Since, however, the structure of the molars and incisors is similar to that obtaining in *G. indicus* and quite distinct from that of *G. hurrianæ*,<sup>2</sup> there seems no doubt that the specimen must be regarded as belonging to a small example of the former species.

#### NESOKIA BANDICOOTA (Bechstein).

Syn. *Nesokia gigantea*, Auct.

*Maxilla and mandible*.—Three fragments of maxillæ and three left mandibular rami, the majority<sup>3</sup> of which were obtained from bed *H* in the Charnel-House, belong to this species. Although the burrowing habits of these animals might account for the occurrence of their bones among the pleistocene fauna, yet the condition of the specimens of this and the next species indicates that they were probably contemporaries. One of the mandibular rami, in which the incisor has been pushed back in its socket, is represented in pl. VIII. figs. 15, 15a. The great width of the incisors characteristic of the genus<sup>4</sup> is well shown in this specimen.

*Limb-bones*.—To this species<sup>5</sup> may probably be referred the imperfect humerus and femur represented in pl. VIII. figs. 1 and 2; while the larger femur represented in fig. 3 of the same plate may perhaps belong to an unusually large individual of the same species. These bones are relatively stouter than the corresponding elements of the skeleton of *Mus decumanus*.

#### NESOKIA KOK, Gray.

*Crania*.—The imperfect cranium of this species represented in pl. VIII. figs. 13,

<sup>1</sup> In the enlarged figures the artist has made the teeth of the two specimens too nearly equal in size.

<sup>2</sup> See Blanford, "Zoology and Geology of Eastern Persia," p. 69. (1876).

<sup>3</sup> Owing to the breaking of these specimens in transit their numbers were partially destroyed.

<sup>4</sup> The genus occurs in the Siwaliks; see 'Cat. Foss. Mamm. Brit. Mus.' pt. I. p. 226. (1885).

<sup>5</sup> There is no example of the skeleton of a *Nesokia* in the British Museum.

13a was obtained from bed *Cb* in the Cathedral; and there is another specimen from bed *B* in the Charnel-House.

*Mandible*.—Mandibular rami are comparatively common, and have been obtained from beds well down in the series in both the Cathedral and Charnel-House caves; the specimen<sup>1</sup> figured in pl. VIII. figs. 14, 14a is from bed *Ch* in the former.

*Limb-bones*.—The imperfect femur represented in fig. 4 of the above plate, as being smaller than the corresponding bone provisionally referred to *N. bandicoota*, probably belongs to the present species. A humerus (No. F. 347) from bed *Ca* in the Cathedral agrees in relative size with the figured femur.

MUS METTADA<sup>2</sup> (Gray).

Syn. *Golunda mettada*, Gray.

*Skull*.—An imperfect skull and numerous mandibular rami (No. F. 209) of this species have been obtained from the Charnel-House, but the extremely fresh appearance of these specimens, coupled with the burrowing habits of the species, renders it doubtful whether they are really contemporaneous with the pleistocene fauna. The mandible of this species is readily distinguished from that of *Golunda ellioti* by its inferior vertical depth, and a specimen of a left mandibular ramus (No. F. 209a) from bed *Cd* in the Cathedral, which is well fossilized, probably indicates the occurrence of the species among the pleistocene fauna.

MUS PLATYTHRIX, Sykes.

Syn. *Leggada platythrix*, Gray.

*Skull*.—Of this small burrowing mouse an imperfect cranium and several mandibular rami (No. F. 210) have been obtained from the Charnel-House, but their fresh condition points to their recent introduction.

MUS (?) *sp. var.*

*Mandible*.—Three species of *Muridae* apparently distinct from any of those specifically named in this memoir are indicated by mandibular rami, which from their well-mineralized condition are apparently contemporaneous with the pleistocene fauna. The first specimen (No. F. 339) belongs to the right side, and the length of the three molars is 0.29 inch; it was obtained from bed *Cd* in the Cathedral. The second (No. F. 340) is from bed *X* in the Charnel-House, and is rather larger than *Mus mettada*; a fragment of the right maxilla probably belongs to the same individual. The third form is represented by a left mandibular ramus (No. F. 341) from the same bed, which is slightly larger than *Mus platythrix*.

GOLUNDA ELLIOTI, Gray.

*Skull*.—Several specimens (No. F. 211) of the cranium and mandible of this species have been obtained from the Charnel-House, but their unaltered condition indicates their recent origin.

<sup>1</sup> This specimen belongs to the right side, but has been reversed in order to facilitate comparison with fig. 15.

<sup>2</sup> Amended from *mettada*; see W. T. Blanford, 'Journ. As. Soc. Beng.' vol. XLV. pt. 2. p. 170. note (1876), where it is shown that the species is not a *Golunda*.



*HYSTRIX CRASSIDENS*, n. sp., *nobis*.

*Definition*.—This form<sup>1</sup> is considerably larger than *H. hirsutirostris*, from which it is also distinguished by the circumstance that the upper incisors are much wider than the lower.

*Upper incisors*.—The extremities of a pair of upper incisors are figured in pl. VIII. fig. 19; another left tooth being represented from the lateral aspect in fig. 20. The measurements of the latter and of an upper incisor of *H. hirsutirostris* are as follows.

	<i>H. crassidens.</i>	<i>H. hirsutirostris.</i>
Antero-posterior diameter . . . . .	0.44	0.30
Transverse do. . . . .	0.32	0.22

*Mandible*.—The left ramus of a complete immature mandible is figured in pl. VIII. figs. 17, 17a;  $\overline{mm.4}$  is still *in situ*,  $\overline{m.3}$  has not come into wear, and the incisor is pushed partly out of its alveolus. The contour of this specimen agrees very closely with the mandible of *H. hirsutirostris*, but the space occupied by the molar series is longer; the latter feature being still better exemplified in a rather older example represented in fig. 16, where  $\overline{m.3}$  is more protruded, and  $\overline{pm.4}$  is seen *in alveolo*. In the latter specimen the length of the space occupied by the three true molars is 1.22 inches, the corresponding length in a somewhat older example of *H. hirsutirostris* being 1.05 inches. The incisor of the figured mandible agrees in width with that of the living species, and is much narrower than the upper incisor of the fossil, and since the same feature is exhibited by all the lower fossil incisors (the extremities of a pair being represented in fig. 21), it may be taken as a character of the species. The concave surface of the lower incisors of the fossil is less narrowed than in the living species. The dimensions of the recent and fossil lower incisors are as follows.

	<i>H. crassidens.</i>	<i>H. hirsutirostris.</i>
Antero-posterior diameter . . . . .	0.32	0.28
Transverse do. . . . .	0.25	0.25

*Cheek-teeth*.—Beyond their superior size it does not appear that the cheek-teeth of the fossil can be distinguished from those of the recent species.<sup>2</sup> A detached right upper premolar is represented in fig. 18 to show the large dimensions which these teeth attain, the antero-posterior diameter of the base of the crown being 0.5 inch.

*Humerus*.—A specimen of the right humerus, wanting the proximal epiphysis, is represented in pl. VIII. fig. 6; it is of considerably larger size than the corresponding bone of *H. hirsutirostris*, from which it is also distinguished by the shorter deltoid ridge (*dr*).

*Distinctness and affinities*.—The difference in the size of the upper and lower incisors appears to be a character by which the Karnul porcupine is distinguished

<sup>1</sup> Referred in 'Rec. Geol. Surv. Ind.' vol. XIX. p. 120. to *H. hirsutirostris*. The writer follows Prof. Flower in adopting the latter name in place of *H. leucura*.

<sup>2</sup> The narrowness of the true molars in the specimen represented in fig. 17, 17a is due to their very early stage of wear.

not only from *H. hirsutirostris*, but from all other existing species. In respect of size the Siwalik *H. sivalensis*<sup>1</sup> agrees with the fossil, but is distinguished by its low-crowned and rooted molars; and since the writer has been unable to identify the Karnul form with any other fossil porcupine it is regarded as a new species, which may be known as *H. crassidens*. It is probable that this species is the connecting link between the Siwalik and the existing Indian porcupines.

*Horizon*.—The majority of the remains of the present species were obtained from the Cathedral cave, and mainly from the bed *Cd*, although some were met with in beds *C*, *Cc*, *Ce*, and *Cf*.

ATHERURA KARNULIENSIS, n. sp., nobis.

*Distribution of the genus*.—The genus *Atherura* is now confined to west Africa and the regions on the eastern side of the bay of Bengal. The Oriental *A. fasciculata* is rather larger than the Ethiopian *A. africana*, but is closely allied.

*Definition*.—The present species is rather larger than *A. fasciculata*, and distinguished by the greater bevelling of the lateral borders of the anterior surface of the incisors.

*Incisors*.—The species is represented only by a few upper and lower incisors, two of which, obtained from bed *Cd* in the Cathedral cave, are figured in pl. VIII. figs. 22, 23. Compared with the incisors of *A. fasciculata* these teeth indicate a slightly larger form, and are distinguished by the more-marked bevelling of their outer edges, and a difference in their curvature. They are still larger than the incisors of *A. africana*, but much smaller than those of any existing species of *Hystrix*. Their resemblance to the incisors of *Atherura* is indeed so close as to leave little, if any, doubt as to their generic identity, and since they appear to indicate a form decidedly distinct from either of the existing species it has been thought well to give to this form the name of *A. karnuliensis*. The rarity of the remains of *Atherura* as compared with those of *Hystrix* seems to indicate that the former genus was dying out in Madras in the pleistocene, but its occurrence there is of considerable importance as tending to bridge over the enormous interval separating the areas respectively inhabited by the two existing species.

LEPUS (cf. NIGRICOLLIS, F. Cuvier).

*Mandible*.—In the absence of any evidence to the contrary the remains of the Karnul hare are provisionally referred to the existing south Indian species, although they are really insufficient for specific determination. There are three specimens of imperfect right mandibular rami (No. F. 218), of which the least imperfect was obtained from bed *Ca* in the Cathedral, while the other two were found in bed *Aa* in the Chaper-House.

*Limb-bones and vertebræ*.—In the Cathedral, Charnel-House, and Purgatory caves limb-bones and vertebræ of the hare are very common, and extend to beds low down

<sup>1</sup> *Supra*. vol. III. p. 109.

in the series. A humerus from the Purgatory cave is figured in pl. VIII. fig. 7.

*EQUUS ASINUS*, Linn.

*Definition of the term.*—Under this specific name may be included both the domestic races, and the wild asses of Nubia and Somali-land, which are referred to two races by Mr. Sclater.<sup>1</sup>

*Molars.*—The much-worn third right upper true molar, of which the crown surface is represented in pl. IX. fig. 15, was obtained from bed *Cf* in the Cathedral, and agrees so exactly with the corresponding tooth of the domestic *E. asinus* that there is every probability of its specific identity.<sup>2</sup> This specimen, of which the antero-posterior diameter is only 0·89 inch, is in a thoroughly fossilized condition. A little-worn left upper tooth belonging to the middle of the cheek-series (No. F. 253) from bed *Cb* in the same cave agrees in relative size with the preceding specimen; its antero-posterior diameter being 0·85, and the transverse 0·79 inch. The third right lower true molar from bed *Cf* in the Cathedral represented in fig. 11 of the same plate agrees so exactly with the corresponding upper tooth that it might have been thought to have belonged to the same individual, were it not that it is in a less worn condition. The antero-posterior diameter of this specimen is 1·08 inches. The much-worn left lower tooth represented in fig. 12 of the same plate was obtained from bed *Ca* in the same cave, and from its very small size is evidently  $\overline{m.1}$ ; its length is 0·8 inch.

*Metatarsal.*—A right third metatarsal<sup>3</sup> (No. F. 258) from bed *Ca* in the Cathedral agrees in relative size with the teeth. The length of this specimen is 8·2, and the transverse diameter of the distal extremity 1·54 inches.

*Distribution.*—The existing wild races of *E. asinus* being confined to north Africa it is extremely interesting to find evidence in the pleistocene of southern India of a form which there is every reason to regard as specifically the same, and which not improbably indicates that the African races originally migrated from India. A fragment of the right ramus of the mandible of a small species of *Equus* from the pleistocene of the Narbada (British Museum No. M. 2690<sup>4</sup>) may not improbably indicate the existence of the present or an allied species in that area.

*EQUUS*, sp. a.

*Upper molars.*—Several molars of an *Equus* of superior size to *E. asinus*, and agreeing approximately in this respect with *E. onager* of north-western India and Persia have been obtained from the Cathedral cave. Three of these specimens belonging to the upper jaw are represented in pl. IX. figs. 14, 16, 17; those in figs.

<sup>1</sup> 'Proc. Zool. Soc.' 1884. p. 542. *Equus taniopus*, Heuglin, is a synonym of one of these forms, and the inclusion of both in *E. asinus* renders unnecessary the note in reference to *E. taniopus* given in vol. II. p. xi. of this work.

<sup>2</sup> There are apparently no means of distinguishing the teeth of *E. asinus* from those of a very small pony, but the absence of any wild diminutive species of true horses in India and Africa renders it highly improbable that the Karnul *Equus* belonged to such a form.

<sup>3</sup> Noticed by Mr. Foote in the 'Rec. Geol. Surv. Ind.' vol. XVII. p. 204 (No. 2).

<sup>4</sup> "Cat. Foss. Mamm. Brit. Mus." pt. III. p. 73 (1885).

14 and 17 being from the middle of the cheek-series of the left side, and the one in fig. 16 the last upper true molar of the same side; two are from bed *Cc*, while the third is from *Cd*. These teeth agree with those of existing species in the excessive length of the antero-internal pillar (*e*), and are inferior in size to *E. namadicus* of the Narbada pleistocene.<sup>1</sup> The specimen represented in fig. 16 appears scarcely larger than the corresponding opposite tooth of *E. asinus* represented in fig. 15; but this is accounted for by its much earlier stage of wear, its antero-posterior diameter at the horizontal plane corresponding to that of the latter specimen being 0.98 inch.

*Lower molar*.—The third right lower true molar from bed *Cb* in the Cathedral represented in fig. 13 exhibits the difference in size between the corresponding tooth of *E. asinus* (fig. 11).

*Metatarsal*.—A right third metatarsal (No. F. 259) from bed *Cf* in the Cathedral, which has lost a portion of its distal extremity, agrees in relative size with the foregoing teeth; its extreme length being 9.3 inches. This specimen is much smaller than the average of the metatarsals of the fossil races of *E. caballus* (and therefore than those of *E. namadicus*), and apparently indicates a species of the size of *E. onager*.

*Affinities*.—The foregoing specimens are insufficient for specific distinction, and all that can be said about them is that they indicate a species superior in size to *E. asinus*, which is certainly distinct both from the larger *E. namadicus* of the earlier pleistocene, and *E. sivalensis*<sup>2</sup> of the pliocene of India. This species was about equal in dimensions to the existing Indian *E. onager* and some of the south African species;<sup>3</sup> and, judging from the marked Ethiopian facies of a considerable portion of the Karnul fauna, and the absence at the present day of any existing wild *Equus* in southern India, it is not improbable that its affinities may be with the latter.

#### RHINOCEROS KARNULIENSIS, nobis.<sup>4</sup>

*History*.—The remains on which this species is founded were provisionally identified by Mr. Foote<sup>5</sup> with *R. sondaicus*, but their distinctness was shown by the present writer in the paper cited above. The remains comprise numerous detached upper and lower cheek-teeth, many of which are imperfect, the greater portion of the left ramus of the mandible, a fragment of a right ramus with one true molar, the greater part of a humerus, three imperfect cervical vertebræ, and the distal half of a metapodial. The mandible and the more perfect teeth, to which comparisons will be mainly confined, are figured in pl. X.

*Mandible*.—It will be convenient to commence the description with the left mandibular ramus, of which two views are given on a scale of one half in pl. X.

<sup>1</sup> *Vide supra*. vol. II. pl. XIV. fig. 3—on the assumption that some of the specimens are premolars.

<sup>2</sup> Distinguished by the antero-posterior shortness of the antero-internal pillar of the upper cheek-teeth.

<sup>3</sup> In the upper molars of *E. zebra* figured by Rütimeyer in the "Pferde der Quaternär-Epoche" ('Abh. Schweiz. pal. Ges.' vol. II.) pls. I. and II. fig. 7 (1877), the antero-internal pillar is more elongated antero-posteriorly.

<sup>4</sup> 'Rec. Geol. Surv. Ind.' vol. XIX. p. 120 (1886).

<sup>5</sup> *Ibid.* vol. XVIII. p. 232 (*R. javanicus*).

figs. 4, 4a. This specimen comprises the greater portion of the horizontal ramus and the hinder part of the symphysis; the last five cheek-teeth are *in situ*, and from their worn condition indicate that their owner was an adult individual; the alveolus of  $\overline{\text{pm.2}}$  still remains, but as there is no trace of that of  $\overline{\text{pm.1}}$  the latter tooth must have totally disappeared. In size the specimen corresponds with the mandible of *R. sondaicus*. In the broken extremity of the symphysis there is no trace of alveoli for canines, and this circumstance, together with the backward extension of the symphysis to the anterior border of  $\overline{\text{pm.3}}$  (fig. 4), the convexity of the inferior border of the ramus, the sudden inward curvature of the external border of the ramus in advance of the same tooth, the backward position of the mentary foramen (*for.*), and the narrow, deep, symphyseal channel, indicate that the specimen belongs to that group<sup>1</sup> of rhinoceroses in which the canines are usually absent,<sup>2</sup> and all the known forms are bicorn. The length of the space occupied by the five cheek-teeth is 7·6 inches, and the length of  $\overline{\text{m.3}}$  1·9 inches. The cheek-teeth are remarkable for the extremely thick coat of cement which invests the bases of their crowns; they have no trace of any external cingulum, but do not present any other well-marked specific characters. The fragment of a right mandibular ramus (No. F. 238) containing the slightly worn  $\overline{\text{m.3}}$  is of rather larger size, the length of the tooth being 2·0 inches.

*Upper true molars.*—Of the upper true molars the crowns<sup>3</sup> of the associated left  $\overline{\text{m.2}}$  and  $\overline{\text{m.3}}$  are represented in pl. X. figs. 1, 1a, 1b; the collection also contains the crown of the right  $\overline{\text{m.3}}$  of the same individual, and a less perfect specimen of the right  $\overline{\text{m.1}}$  or  $\overline{\text{m.2}}$  (No. F. 234). The figured specimens are in a middle condition of wear, and belong to the more common type of structure, as exemplified in *R. sondaicus*. The first and second costæ (*c*, *d*) are prominent and form a well-marked buttress,<sup>4</sup> and the external surface is deeply curved; there is a distinct cingulum on the anterior and inner surfaces of the anterior collis (*a*), which is totally absent on the posterior collis (*b*); the two colles are separated by a considerable interval: the crochet (*e*) is well developed and has a separate accessory tubercle in the median valley, which occurs in all the specimens in the collection; there is no combing-plate, no antecrochet, nor any trace of a tubercle at the entrance of the median valley (*g*), and when more worn the crowns would present only two fossettes. Compared with the molars of *R. sondaicus* the crowns appear to have been relatively rather shorter, and may be described as being probably of a sub-brachydont type.<sup>5</sup> The length of the outer surface of  $\overline{\text{m.2}}$  is 1·8, and that of its anterior surface 2·1 inches.

<sup>1</sup> The Atelodine group (to which *R. deccanensis* belongs); see "Cat. Foss. Mamm. Brit. Mus." pt. III. p. 92.

<sup>2</sup> In *R. persia*, Pohlig ('Quart. Journ. Geol. Soc.' vol. XLII. p. 178), of Maragha lower canines are present.

<sup>3</sup> The roots of all these teeth have been gnawed off by porcupines.

<sup>4</sup> The absence of a buttress is seen in the third right upper true molar of *R. unicornis* represented in figs. 3, 3a of the same plate.

<sup>5</sup> In the preliminary notice these teeth were described as decidedly brachydont. Subsequent examination has, however, shown that owing to their partially worn condition and the fact of the base of the crowns having been gnawed away, it is very difficult to come to a certain conclusion on this point.

*Upper premolars.*—There are unfortunately no perfect upper premolars in the collection; but the inner half of a well-worn right pm.3 is represented in pl. X. fig. 2. This specimen<sup>1</sup> shows that there is no trace of a cingulum on the anterior collis (*a*), and merely an oblique ridge running downwards and backwards on the anterior aspect of the posterior collis (*b*); the two colles unite at their junction for a considerable part of their height. The corresponding portion of the left pm.4 of the same individual (No. F. 135*a*) presents precisely similar features.

*Affinities.*—That the present form is specifically distinct from all the existing Indian species of *Rhinoceros* is self-apparent; and it will not be difficult to show its apparent distinctness from all the fossil species of the same country. In Madras two other species occur in a fossil condition; the first of which appears identical with the existing *R. unicornis*, and is known by the slightly-worn third right upper true molar represented in pl. X. figs. 3, 3*a*, which was obtained several years ago by Mr. Foote from a turbary, and is interesting as showing the extensive range of this species in past times.<sup>2</sup> The second species, *R. deccanensis*, Foote,<sup>3</sup> is of pleistocene age, and, although of somewhat superior size, agrees with the present form in the absence of lower canines, and in the general plan of structure of the upper true molars. The teeth are, however, described as being markedly hypsodont, and without any appreciable quantity of cement, while in the upper true molars the external surface is nearly flat, and the colles are approximated and show no trace of any internal cingulum. In the premolars, however, there is a very strongly-marked cingulum completely surrounding the inner half of the crown,<sup>4</sup> and the inner half of the anterior colles appears less flattened. The premolars are moreover larger in proportion to the true molars, the antero-posterior diameter of pm.4 being 1.55 and that of m.2 1.9, while in the present form the corresponding dimensions are 1.15 and 1.7. In the mandible the arcuation of the inferior border, and especially the upward inclination of its anterior moiety, is very much more strongly marked,<sup>5</sup> and the bases of the crowns of pm.2 and pm.3 are placed on a considerably higher level than that of pm.4, instead of in the same horizontal line. The symphyseal channel appears wider, much less distinctly defined, and more open; pm.2 is apparently larger and more widely separated from its fellow of the opposite side, while there is a distinct cingulum at the two extremities of the outer surfaces of the premolars, but no trace of a mentary foramen below pm.3. From the structure of that portion of the symphysis still remaining it appears probable that this part was rather shorter in the fossil. With the fossil rhinoceroses of the Siwaliks the present form has no affinity; the only bicorn species (*R. platyrhinus*) having upper cheek teeth of a totally different type of structure. The Maragha *R. persiae*<sup>6</sup> is also an entirely different form.

<sup>1</sup> It is highly probable that this and the next specimen belong to the same individual as the true molars.

<sup>2</sup> The artist has foreshortened the inner surfaces of the colles in fig. 3, which makes the crown look lower than it really is, but its true height is shown in fig. 3*a*.

<sup>3</sup> *Supra.* vol. I. pp. 1-17. pls. I.-III.

<sup>4</sup> Compare Foote, *op. cit.* pl. I.

<sup>5</sup> Compare Foote, pl. II. fig. 3.

<sup>6</sup> *Vide supra.* p. 41, note 2.



Of the fossil European members of the Atelodine group occurring above the Pikermi horizon the one which apparently comes nearest to the Karnul rhinoceros is *R. etruscus*. The upper cheek-dentition of that species is, however, apparently somewhat more brachydont, while the upper premolars usually have a very distinct horizontal cingulum on their inner aspect,<sup>1</sup> and are larger in proportion to the true molars. The latter are, however, very like those of the fossil, and show a cingulum on the inner aspect of the anterior collis in the two last of the series,<sup>2</sup> although the second costa does not extend to the base of the crown. The mandible also approaches the Karnul jaw in general contour, but the symphyseal channel is shallower and less defined, while the outer surface of the horizontal ramus inclines less inwardly in front of  $\overline{\text{pm.3}}$ , and the mentary foramen is usually double and has its hinder aperture placed below  $\overline{\text{pm.2}}$  instead of  $\overline{\text{pm.3}}$ , and nearer to the inferior border of the ramus;<sup>3</sup> there is also a distinct cingulum at the two extremities of the outer surface of the lower cheek-teeth.<sup>4</sup>

Of the two existing African rhinoceroses *R. sinuatus* has no affinity with the present form, but *R. bicornis* appears very closely allied. The upper cheek-teeth of the latter have, however, considerably higher crowns, the second costa in the true molars does not extend to the base of the crown, and the buttress in the same teeth appears less strongly marked, while the premolars have a slight cingulum, which does not present an oblique ridge on the posterior collis. The contour of the inferior border of the mandible is also more curved,<sup>5</sup> but the hinder part of the symphysis is extremely like that of the fossil, many specimens showing the same well-defined channel. In most examples of the existing species the mentary foramen occupies the same position as in the fossil,<sup>6</sup> but the symphysis of the latter was almost certainly somewhat longer anteriorly, and was perhaps intermediate in this respect between *R. bicornis* and *R. etruscus*. The bicorn *R. pachygnathus* of Pikermi appears closely allied to *R. bicornis*, and differs from the fossil in much the same respects as the latter.

*Summary*.—The usual ill fortune of the palæontologist obtains in the present instance, for had but the mandibular symphysis of the Karnul rhinoceros been complete there would have been no question whether its affinities were nearest to *R. etruscus* and *R. deccanensis*, or to *R. bicornis*. There is, however, apparently but little doubt as to its specific distinctness from the first of these three species; and if it be assumed that the presence of the cingulum in the upper premolars, the absence of a large amount of cement in the cheek-teeth, the contour of the mandible, and the position of the mentary foramen, are constant characters in the second species, it will be evident that the present form cannot be identified with the Deccan rhinoceros. The apparently more hypsodont dentition of *R. bicornis* and the difference in the contour

<sup>1</sup> Compare Boyd-Dawkins "Quart. Journ. Geol. Soc." vol. XXIV. pl. VII. fig. 1 (1868).

<sup>2</sup> *Ibid.* pl. VII. fig. 1. and VIII. fig. 4.

<sup>4</sup> Compare Dawkins, *op. cit.* pl. VII. fig. 3.

<sup>6</sup> It is occasionally situated below  $\overline{\text{pm.2}}$ .

<sup>3</sup> Compare "Falconer's Palæontological Memoirs," vol. II. pl. XXVII.

<sup>5</sup> Compare Blainville's "Ostéographie"—genus *Rhinoceros*, pl. III.

of the inferior border of the mandible, together with the apparently longer symphysis, seems to indicate specific distinction in this instance also.

These conclusions entail the necessity of at least provisionally regarding the Karnul rhinoceros as specifically distinct from all other described forms. Additional specimens are, however, essential to a fuller comprehension of its affinities, and all that can be said at present is that the species appears to show characters connecting it on the one hand with *R. etruscus* and *R. deccanensis*, and on the other with *R. bicornis*.

*Horizon*.—The majority of the specimens were obtained from the Cathedral cave, the more perfect ones being found in the beds *C*, *Ob*, *Cc*, and *Cd*, and broken fragments in *Ce* and *Cf*.<sup>1</sup> Specimens were also found in the Charnel-House, the right upper true molar (No. F. 234) noticed on page 41 being apparently the one alluded to by Mr. Foote<sup>2</sup> from that cave.

Bos, or BUBALUS, sp.

*Limb-bones, teeth, and mandible*.—The remains of ruminants belonging either to one or both of the above-mentioned genera are abundant in the Cathedral, especially in the beds *Cb*, *Cc*, and *Cd*, and comprise limb-bones, detached teeth, and several imperfect mandibular rami. In the absence, however, of any of the characteristic portions of the cranium it seems impossible to make a generic determination of these specimens.

BOSELAPHUS TRAGOCAMELUS (Pallas).

Syn. *Portax picta*, H. Smith.

*Upper molars*.—Several upper molars of this species were obtained from the

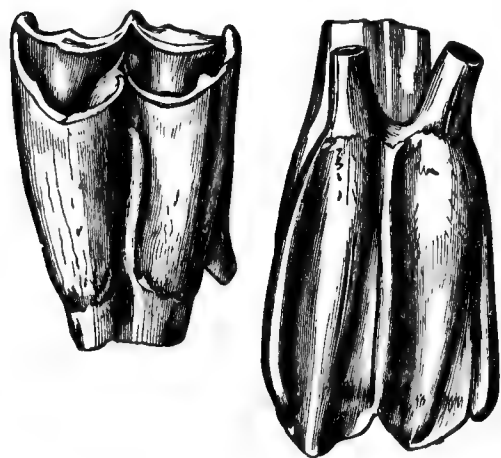


Fig. 2. *Boselaphus tragocamelus*. The second left upper true molar, in an almost unworn condition: recent, India.

Cathedral in beds *Ca*, *Cb*, *Cc*, and *Cd*, of which three are represented in pl. XI. figs. 7, 8, 9. The slightly worn specimens represented from the inner aspects in figs. 7, 9, judging from their comparatively short crowns, are probably examples of m.1 (of the right side), while the unworn tooth of which the outer aspect is shown in fig. 8 is m.2 of the same side. These teeth agree precisely with the molars of the existing race, of which the left m.2 of a female is figured in the accompanying woodcut, and exhibit the characteristic tall crown, with the long and slender accessory inner column, which is attached entirely to the hinder crescent. It is very difficult to point out any characters by which these teeth can be distinguished from those of the Siwalik *Boselaphus* figured in plate XIII. of the preceding volume of this work.

*Lower molar and mandible*.—An unworn left (second ?) lower true molar, which

<sup>1</sup> Vide Foote 'Rec. Geol. Surv. Ind.' vol. XVIII. p. 230.

<sup>2</sup> *Ibid.* vol. XVII. p. 204.



has lost part of the inner column of the anterior lobe, from bed *Aa* in the Chapter-House, is represented from the external aspect in pl. XI. fig. 10. Mr. Foote<sup>1</sup> refers to this species a fragment of the left ramus of a mandible (No. F. 285) from bed *L* in the Charnel-House, containing the much-worn  $\overline{m.1}$  and  $\overline{m.2}$ ; while the right ramus of a very young animal with the three milk-molars represented in pl. XI. figs. 14, 14a may also be referred to it. The latter agrees very closely with a slightly older specimen of the opposite ramus of the Siwalik form represented in vol. III. pl. XIII. fig. 4.

GENUS, *non. det.*

*Upper molar.*—The partially-worn and slightly imperfect left upper true molar from bed *Cb* of the Cathedral represented in pl. XI. figs. 2, 2a apparently indicates the occurrence of a large antelope belonging to the group which comprises the genera *Oryx*, *Palæoryx*, *Addax*, and *Hippotragus*. The tooth is characterized by the square form of the base of the crown, the large size of the inner accessory column, and the well-developed costæ on the outer surface. Among living antelopes the specimen comes nearest to the teeth of *Oryx* and *Hippotragus*, but apparently indicates a more brachydont form; it differs from the former by being narrower, and by the absence of the antero-posterior expansion of the accessory column. The molars of the Pikermi species of *Palæoryx* have a flatter outer surface, and a very minute accessory column; but the tooth of the so-called *Antilope boödon*, from the pliocene of France, which is referred by M. Depéret<sup>2</sup> to *Palæoryx* is exceedingly like the Indian fossil. The latter differs from the molars of *Oreas*, *Strepsiceros*, and *Palæoreas*, by the more marked external costæ, and from the existing species of the two former genera by the presence of the large accessory column, although resembling the fossil forms in this respect.<sup>3</sup>

GAZELLA BENETTI (Sykes).

*Mandible.*—The imperfect left mandibular ramus from bed *Cu* in the Cathedral represented in pl. XI. figs. 15, 15a agrees precisely with the mandible of a female of this species in the British Museum (No. 617d)<sup>4</sup>; the relative shortness of the pre-molars, which is a characteristic feature of the genus, being well shown in the fossil. A fragment of the left ramus of the mandible of a male (No. F. 279) was obtained from bed *I* in the Charnel-House; and it is not improbable that an atlas vertebra (No. F. 279a) from the Purgatory cave, an axis (No. F. 279b) from the Cathedral, and some metapodials and phalangeals (No. 279c) may also belong to the present species.

ANTILOPE CERVICAPRA (Linn).

Syn. *A. bezoartica*, Auct.

*Upper molar.*—The partially-worn second left upper true molar from bed *Cb* in

<sup>1</sup> 'Rec. Geol. Surv. Ind.' vol. XVII. p. 206 (No. 1).

<sup>2</sup> 'Thésés. Facult. Sci. Paris.' sér. A. No. 67—'Bassin Tertiaire du Roussillon.' p. 247. pl. III. figs. 9, 10 (1885).

<sup>3</sup> *Vide supra.* pp. 8, 9.

<sup>4</sup> Gray "Hand-list of Edentate, Ruminant, and Thick-Skinned Animals," p. 109 (1873).

the Cathedral represented in pl. XI. figs. 13, 13a agrees precisely with the corresponding tooth of this species, and may accordingly be taken as indicating its occurrence among the Karnul fauna.

TETRACEROS QUADRICORNIS (Blainville).

*Mandible*.—The imperfect left mandibular ramus containing all the cheek-teeth except  $\overline{\text{pm.2}}$  represented in pl. XI. figs. 12, 12a was obtained from bed *Cd* in the Cathedral. This specimen, which exhibits the slender external accessory column in the true molars characteristic of some individuals of this species,<sup>1</sup> cannot be distinguished from the corresponding portion of the mandible of existing examples of the four-horned antelope, and exhibits the relatively large size of the premolars characteristic of the genus. The relatively large size of these teeth may be seen by comparing the figures of the specimen with those of the mandible of *Gazella bennetti* represented in figs. 15, 15a of the same plate, when it will be observed that while the length of  $\overline{\text{m.3}}$  is nearly the same in the two specimens, the length of the space occupied by the three premolars in the latter is rather less than the united length of the two hinder teeth of that series in the present specimen. *Tetraceros quadricornis* is one of the commonest of the larger Madras mammals, and may probably be regarded as the descendant of the smaller *T. daviesi*<sup>2</sup> of the Siwaliks.

CERVUS ARISTOTELIS, Cuvier.

*Antler*.—An imperfect antler from bed *Ca* in the Cathedral agrees very closely with that of the existing sambar.

*Molars*.—Numerous upper molars indistinguishable from those of the living race have been obtained from beds *Cb*, *Cc*, *Cd*, and *Cf*, of the Cathedral, of which two very perfect examples are figured in pl. XI. figs. 5, 5a, and 6, 6a. The specimen represented in figs. 5, 5a is a first left upper true molar, while that in figs. 6, 6a is the second molar of the opposite side. Both teeth are partially worn, and exhibit very clearly the short, squared crowns, with the large accessory column attached at its base to both the adjacent crescents.

*Vertebra and limb-bones*.—It is not improbable that an atlas vertebra (No. F. 305) from bed *Ca* of the Cathedral belongs to this species, and Mr. Foote<sup>3</sup> refers to it an imperfect tibia (No. F. 305,a) and an astragalus (No. F. 305,b) from bed *L* in the Charnel-House.

*Range*.—The species is found throughout India, and thence through Assam and Burma to the Malay peninsula, and also occurs in Ceylon; it has been provisionally recorded from the pleistocene of the Narbada valley.<sup>4</sup>

CERVUS AXIS, Erxleben.

*Molars*.—To this species may be referred the two specimens of third upper true molars from beds *Cb* and *Cc* in the Cathedral represented in pl. XI. figs. 1, 1a, and 3.

<sup>1</sup> *Vide supra*, p. 20.

<sup>2</sup> *Ibid*, p. 19.

<sup>3</sup> 'Rec. Geol. Surv. Ind.' vol. XVII. p. 207 (Nos. 15, 16).

<sup>4</sup> "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 103 (1885).

The specimen in figs. 1, 1a belongs to the right side, and is but slightly worn; it exhibits the comparative hypsodontism characteristic of this species, and the very small size of the inner accessory column. The specimen represented in fig. 3 is considerably more worn, and belongs to the left side. The right first or second lower true molar represented in fig. 4 of the same plate was obtained from bed Cc of the Cathedral.

(?) *CERVULUS MUNTJAC* (Zimmermann).

Syn. *Cervulus aureus*, Auct.

*Upper molar*.—The imperfect tooth from the Purgatory cave represented in pl. XI. figs. 11, 11a agrees exactly with the corresponding portion of the second right upper true molar of the muntjac, and may probably be referred to that species, although it is very difficult to distinguish such an imperfect specimen from the corresponding tooth of *Tetraceros quadricornis*.

*TRAGULUS* (cf. *MEMINNA* [Erxleben]).

*Metapodials*.—Two specimens of the distal half of metapodials wanting the epiphyses (No. F. 307), from bed Cc in the Cathedral, indicate the presence of a chevrotain, which is probably identical with the existing Indian species, among the Karnul fauna.

*SUS CRISTATUS*, Wagner.

*Occurrence*.—Detached teeth of *Sus* occur very commonly in nearly all the beds of the Cathedral, and in many of those of the other caves. The difference in the size of the cheek-teeth indicates the occurrence of two forms, one of which may be identified with the existing Indian species, while the other apparently indicates a new species. Since the third true molars afford the best distinctive characters, comparisons will be in the main confined to these teeth.

*Lower molars*.—Three specimens of the third left lower true molar from beds Cb and Cc in the Cathedral are represented in pl. IX. figs. 1, 2, 4, of which the one in fig. 1 is the most, and that in fig. 4 the least worn.<sup>1</sup> The fragment of the right ramus of a mandible with the three true molars represented in fig. 5 of the same plate was obtained by Mr. Foote from a turbarry in Madras in company with the molar of *Rhinoceros unicornis* figured in pl. X. fig. 3. The teeth of the latter speci-

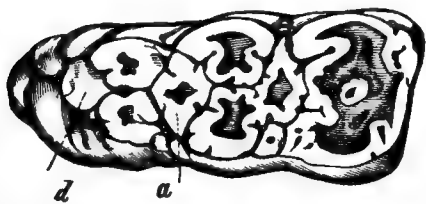


Fig. 3. *Sus cristatus*. The third right lower true molar of a male. Recent.  
†. British Museum. No. 7160.

men, which from the complexity of the talon (*b, c, d*) may be inferred to have belonged to a male, agree exactly in size with those of average individuals of the existing race, of which a third lower molar is figured in the accompanying woodcut; but the Karnul specimens are slightly larger. In regard to the complexity of the talon of the third lower molar there is considerable

<sup>1</sup> The lettering designating the different elements of these teeth is the same as that employed in pl. VII. of vol. III. of the present work.

variation; the complexity being greatest in male animals. The figured specimen is an average example, but in some individuals the portion *d* consists of only a single column<sup>1</sup>; while in others the complexity is as great as in the specimen represented in fig. 5, where there are four distinct columns in this portion. With the exception of one specimen (No. F. 266*b*), which agrees with the one figured in the woodcut, all the Karnul teeth exhibit the extreme complexity of talon which is only sometimes met with in the existing race. In the (probably male) specimen represented in fig. 4 the columns are rather taller, and their inner surface more flattened than in any recent examples which have come under the writer's notice, in both of which respects the specimen approximates to the corresponding tooth of the Siwalik *S. falconeri*, of which specimens are represented in vol. III. pl. VII. figs. 1 and 2 of this work. In male individuals of that species (vol. III. pl. VII. fig. 2) the third molar is considerably larger than the Karnul teeth; but in the female (vol. III. pl. VII. fig. 1) this tooth is very nearly of the same length as the latter. The Karnul and other teeth of *S. cristatus* may, however, be easily distinguished from those of females of *S. falconeri*, by the smaller interval between the column marked *a* and the anterior extremity, which is indicative of the less degree of lateral compression and antero-posterior extension of the main columns of the former teeth. This feature is, however, rather less marked in the specimen represented in pl. IX. fig. 4 than in the other teeth.

*Upper molar.*—The slightly-worn third right upper true molar from bed *Cd* in the Cathedral represented in pl. IX. fig. 7 agrees in relative size and the great complexity of the talon (*a*, *b*, *c*) with the lower teeth. There are two equal-sized specimens (No. F. 260*b*, 267*b*) from beds *Cb* and *Cd* in the Cathedral, in the latter of which the talon is still more complex.

*Lower canine.*—The anterior portion of the left lower canine of a male from bed *Ca* in the Cathedral represented in pl. IX. fig. 10 can scarcely be distinguished from the corresponding tooth of large individuals of the existing race, and indicates that some of the molars described above belong to the same sex.

*Range and affinity.*—The Karnul specimens carry back *Sus cristatus* to the later pleistocene, and the impossibility of distinguishing the third lower Karnul molars from the corresponding tooth of the mandible from the Narbada described on page 85 of the preceding volume of this work<sup>2</sup> almost certainly indicates the existence of the species in the earlier part of the same period. The tendency to a greater complexity of structure in the last molar of the fossil race appears to show decided evidence of affinity with *S. falconeri*, and to indicate the probability of the living species being a descendant from the Siwalik form which has lost the elongated facial portion of the cranium characteristic of the latter; and in the sequel it is suggested that the next species may be the survivor of the intermediate form. The existence

<sup>1</sup> In vol. III. p. 75 it is stated (from the comparison of an insufficient number of specimens) that the portion *d* always consists of only a single column.

<sup>2</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 266. Nos. 36843, 36725 (1885).

of an allied form in the reputed pliocene of Algiers is apparently afforded by *S. phacochaeroides*, Thomas,<sup>1</sup> in which the third lower true molar agrees very closely in size and structure with the specimen represented in pl. IX. fig. 4, although the development of lateral accessory columns in the talon is somewhat greater.

*SUS KARNULIENSIS*, n. sp. *nobis*.

*Definition*.—This provisional species agrees in size with *S. falconeri*, but in the general structure of the molars with *S. cristatus*, although some specimens of these teeth approach those of certain examples of the former.

*Lower molar*.—The much-worn third left lower true molar from bed *Cd* in the Cathedral represented in pl. IX. fig. 3, and the somewhat less-worn tooth of the opposite side from bed *Cb* represented in fig. 8 indicate a species allied in the structure of these teeth to *S. cristatus*, but of considerably larger size. It appears, indeed, very difficult to detect any structural difference between these teeth and those specimens of the third lower molars of that species in which the talon (*b*, *c*, *d*) is of the most complex type. Compared with the corresponding tooth of the male of the Siwalik *S. falconeri* (*supra*. vol. III. pl. VII. fig. 2) these teeth agree very closely in length, but differ by their inferior width and less elongation of the main columns, so that the interval between the anterior extremity and the point *a* is very much smaller. This difference is still more marked if the Karnul teeth be compared with m.3 of the female of the Siwalik species (vol. III. pl. VII. fig. 1), when it will be seen that in the absolutely smaller Siwalik tooth the above-mentioned interval is greater than in the Karnul teeth. In one male mandible of *S. falconeri* (B.M. No. M. 2012<sup>2</sup>) the third lower true molar is very like the Karnul specimen represented in fig. 3; the interval between the anterior border and *a* being but very slightly smaller.

*Upper molars*.—The well-worn third right upper true molar from bed *Cd* in the Cathedral represented in pl. IX. fig. 6, and the almost unworn corresponding tooth of the opposite side from the same bed represented in fig. 9, agree in relative size with the lower molars. Both specimens exhibit great complexity in the development of the talon (*a*, *b*, *c*), and also of the lateral accessory columns; in fig. 9 there is a supplemental line of small tubercles behind *c* which is wanting in fig. 6. Beyond the circumstance that the accessory columns appear more numerous than in m.3 of *S. cristatus* (fig. 7) these teeth do not appear to differ structurally from examples of that species in which the talon of that tooth is unusually largely developed. Compared with the two specimens of m.3 of *S. falconeri* represented in vol. III. pl. VII. figs. 5, 7, the Karnul teeth differ by their greater relative width, the shorter interval between the anterior extremity and the point *a*, and the lesser antero-posterior elongation of the discs of dentine formed by the abrasion of the main columns. In one male cranium of *S. falconeri* (B.M. No. 15316<sup>3</sup>) m.3 is, however, wider than usual, and thereby approaches the Karnul teeth, although the interval between *a* and

<sup>1</sup> 'Mém. Soc. Géol. France,' sér. 3. vol. III. pt. 2, p. 10. pl. X, fig. 1 (1885).

<sup>2</sup> See "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 264.

<sup>3</sup> *Ibid.* p. 263.

the anterior border is much superior.<sup>1</sup> A slightly-worn second upper true molar from bed *Cc* in the Cathedral agrees with m.2 of *S. cristatus* in the squareness of the crown, and has not the extremely elongated form usually characteristic of slightly worn specimens of this tooth in *S. falconeri* (compare vol. III. pl. VII. fig. 5).

*Distinctness and affinities.*—The structure of the cheek-teeth of the present form indicates that their affinity is nearer to *S. cristatus* and *S. falconeri* than to any other species. Their superior size apparently, however, forbids their reference to the former species, while the differences indicated above appear equally conclusive as to their distinction from the latter; and it is accordingly proposed to refer them to a new species, with the name of *S. karnuliensis*. The resemblance between the teeth of this species and those of certain examples of *S. falconeri* may suggest that the former is the survivor of the form connecting the latter with the existing *S. cristatus*.

#### MANIS GIGANTEA, Illiger.

*Phalangeal.*—The terminal phalangeal of the third digit of the right manus of a large *Manis* represented in pl. VIII. figs. 8, 8a was obtained from bed *Cc* in the Cathedral cave. This specimen indicates a much larger animal than the existing Indian *M. pentadactyla*,<sup>2</sup> and agrees so closely with the corresponding bone of *M. gigantea* of western Africa that it certainly indicates a very closely allied form, which, in the absence of any evidence to the contrary, may be regarded as specifically identical. The fossil specimen is slightly larger than the corresponding bone of a skeleton in the British Museum,<sup>3</sup> of which the total length is 4 feet 6 inches.

*The Siwalik edentate.*—In the first volume<sup>4</sup> of the present work the second phalangeal of the third digit of the manus of an edentate from the lower Siwaliks of Sind was described and figured under the name of *Manis sindiensis*. The opportunity of comparing a cast of this specimen with the corresponding bones of *Manis gigantea* and *Macrotherium giganteum* has, however, convinced the writer that this determination



Fig. 4. *Macrotherium sindiense*. The second phalangeal of the third digit of the manus, viewed from the anterior and distal aspects; from the lower Siwaliks of Sind.  $\frac{1}{2}$ . Indian Museum (No. D. 99).

is erroneous, and that the Siwalik edentate should rather be referred to *Macrotherium*. Compared with *Manis* the specimen (woodcut fig. 4) differs by the supratrochlear portion being shorter, and by the lesser projection of the free borders of the trochleæ, as well as by the superior termination of the posterior surface being higher than that of the anterior, and the narrowness of the ridge dividing the two articular facettes on the proximal surface. In these

respects the specimen agrees very closely with the corresponding bone of *Macro-*

<sup>1</sup> In the Siwalik specimen the talon is less developed than usual, and thereby shows on a superficial examination a closer resemblance to the Karnul teeth than is really the case.

<sup>2</sup> The Karnul form was referred to this species by Mr. Foote in the 'Rec. Geol. Surv. Ind.' vol. XVIII. p. 232.

<sup>3</sup> No. 1458a. See Gray "Hand-List of Edentate, etc., Mammals," p. 10 (1873).

<sup>4</sup> Page 82 (64), pl. VIII. figs. 11-14.



*therium giganteum*, but in the deep concavity of the proximal articular facettes and the more perfect rounding of the distal trochleæ it resembles *Manis*; in size it is intermediate between *Macrotherium giganteum* and *Manis gigantea*. On the whole the characters of this specimen appear nearer to *Macrotherium* than to *Manis*, and it therefore appears advisable to refer it to the former genus, but the above-mentioned resemblance to *Manis*, coupled with the size of the specimen, and the occurrence of *Manis gigantea* in the pleistocene of India, renders it highly probable that the species to which it belonged was a form connecting the generalized *Macrotherium giganteum* of the middle miocene of Europe with the more specialized genus *Manis*.

### III. AVES.

*General*.—The remains of birds are of far less common occurrence in the Karnul caves than those of mammals, and this paucity of specimens, together with the intrinsic difficulty of the determination of imperfect bones of birds,<sup>1</sup> renders the number of determined forms but small. In addition, however, to the forms mentioned below an imperfect humerus (No. F. 319) from bed *Ca* in the Cathedral, agreeing in general characters with the corresponding bone of *Corvus corone*, probably indicates the occurrence of a member of the *Corvidæ*; while three smaller specimens of the homologous bone may perhaps belong to other members of the *Passeres*. Other humeri (No. F. 316) from the same cave not improbably indicate the occurrence of *Columbidæ*; while a right humerus (No. F. 317) from bed *Ca* indicates a genus of *Anatidæ* in which this bone is relatively longer and more slender than in *Anas boscas*. All the determined forms belong to existing Indian species, but there is apparently evidence of a variety of *Francolinus pondicerianus*. The following list indicates the systematic position of the forms described.

ACCIPITRES. <i>Neophron percnopterus</i> (Linn).	GALLINÆ. <i>Francolinus pictus</i> (Jard. and Selby).
? <i>Milvus</i> or <i>Circus</i> , sp.	pondicerianus <sup>2</sup> (Gmelin).
<i>Ketupa ceylonensis</i> (Gmelin).	ALECTORIDES. <i>Grus</i> (cf. <i>communis</i> , Bechst.)
<i>Bubo coromandus</i> (Lath.)	HERODIONES. <i>Ibis melanocephala</i> <sup>2</sup> (Lath.)

#### NEOPHRON PERCNOPTERUS<sup>3</sup> (Linn.)

*Humerus*.—The distal extremity of a left humerus (No. F. 309) from bed *Ca* in the Cathedral agrees exactly in contour with the corresponding bone of the skeleton of this species in the museum of the Royal College of Surgeons, although belonging to a somewhat larger individual. The characteristic deep fossa on the dorsal aspect is well exhibited.

#### (?) MILVUS, or CIRCUS, sp.

*Tarso-metatarsus*.—The distal half of the left tarso-metatarsus of a small raptorial

<sup>1</sup> This difficulty is intensified by the want of a really good collection of bird-skeletons in England.

<sup>2</sup> The writer follows Selater ("List of Animals in Gardens of Zool. Soc." 8th ed. pp. 411, 468 [1883]) in referring these two species respectively to *Francolinus* and *Ibis*, rather than making them the types of the genera *Ortygornis* and *Threskiornis*.

<sup>3</sup> The so-called *N. ginginianus* is included under this name as being at least palæontologically inseparable.

bird from a bed low down in the Cathedral cave, which is figured in the accompanying

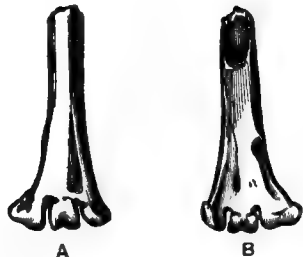


Fig. 5. (?) *Milvus* or *Circus*, sp. The distal half of the left tarso-metatarsus, from the anterior (A) and posterior (B) aspects; from the Cathedral cave. †. Ind. Mus. (No. F. 310).

woodcut, may be referred either to *Milvus*, *Circus*, or one of the allied genera. The fossil specimen agrees very closely in size with the corresponding bone of a skeleton of the widely distributed *Circus cyaneus* (Linn.) preserved in the Museum of the Royal College of Surgeons.

#### KETUPA CEYLONENSIS (Gmelin).

*Limb-bones*.—This species is represented by a right femur<sup>1</sup> (No. F. 313a) and

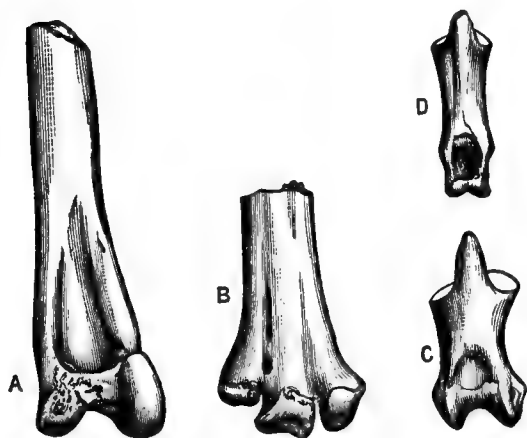


Fig. 6. A.B.D. *Ketupa ceylonensis*. The distal half of the right tibio-tarsus (A), of the right tarso-metatarsus (B), and the 3rd phalangeal of the 3rd digit of the pes (D). C. *Bubo coromandus*. The 2nd phalangeal of the 3rd digit of the pes. All the specimens are from the Cathedral cave.

the distal half of the right tibio-tarsus from bed Ca in the Cathedral, as well as by the distal portion of the right tarso-metatarsus from bed Cb, and the third phalangeal of the third digit of the pes from bed Ca in the same cave; the three last-named bones being figured from the anterior aspect in the accompanying woodcut (fig. 6 a, b, d). These specimens agree exactly with the corresponding bones of the existing bird. As characteristic features in the tibio-tarsus of *Ketupa* and allied genera may be mentioned the absence at the distal extremity of the anterior surface

of a bridge of bone over the extensor tendons, and the presence of a tubercle on the inner border for muscular attachment.

#### BUBO COROMANDUS (Latham).

Syn. *Urrua coromanda*, Auct.

*Phalangeal*.—The second phalangeal of the third digit of the pes of a very large owl from bed Cc in the Cathedral represented in woodcut fig. 6c, agrees, as far as can be determined from comparison with a dried specimen, with the corresponding bone of *Bubo coromandus*, which now inhabits the Carnatic, lower Bengal, and the outer Himalaya.

#### FRANCOLINUS PICTUS (Jardine and Selby).

*Tarso-metatarsus*.—Evidence of the existence of the painted francolin, which replaces the black francolin (*F. vulgaris*) in central and parts of southern India, is

<sup>1</sup> The collection also contains a perfect right tibia (No. F. 311) marked as from bed Ca in the Cathedral, which, however, appears to be recent.



afforded by the apparently tarso-metatarsus represented in woodcut fig. 7. This

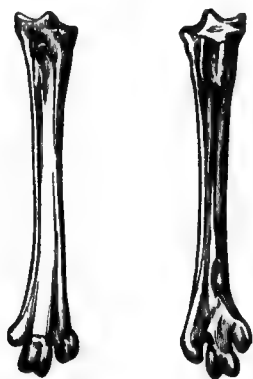


Fig. 7. *Francolinus pictus*. The left tarso-metatarsus; from the Cathedral cave (bed Ca). †. Indian Museum (No. F. 318).

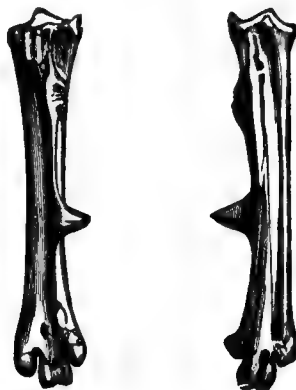


Fig. 8. *Francolinus pondicerianus*. The left tarso-metatarsus; from the Cathedral cave (bed Ca). †. Indian Museum (No. F. 342).

specimen was obtained from bed Ca in the Cathedral, and cannot be distinguished from the corresponding bone of the existing bird; it is, however, also difficult to distinguish it from the tarso-metatarsus of the female of *Francolinus pondicerianus*.

*Other bones.*—A left femur and tibio-tarsus (No. F. 342a) from beds Ca and Cb in the same cave may probably be likewise referred to the present species.

#### FRANCOLINUS PONDICERIANUS (Gmelin).

Syn. *Ortygornis pondiceriana*, Auct.

*Tarso-metatarsus.*—The left tarso-metatarsus from bed Ca in the Cathedral represented in woodcut fig. 8 is furnished with two spurs, of which the greater portion of the uppermost one is broken away. The specimen is much smaller than the corresponding bone of the Indian *Galloperdix*, or the west African *Francolinus bicalcaratus*, and agrees in point of size with the metatarsus of the grey francolin. In existing males of the latter species there is, however, normally but one spur, although Jerdon states that a secondary spur is occasionally found 'at the base of the normal one.'<sup>1</sup> In view of this variation, and it being certain that the fossil bone cannot belong to any other existing Indian bird, it is provisionally regarded as indicating the occurrence of a variety of the grey francolin among the Karnul fauna.

#### GRUS (cf. COMMUNIS, Bechstein).

*Metacarpus.*—Two specimens of the left metacarpus (No. F. 314) of a large wader agree so closely with the corresponding bone of *Grus communis* that they may be regarded as indicating the occurrence among the Karnul fauna of a member of that genus, which is very probably identical with the above-named species.

#### IBIS MELANOCEPHALA (Latham).

Syn. *Threskiornis melanocephala*, Auct.

*Limb-bones.*—Of the black-headed ibis, which is widely distributed in south-

<sup>1</sup> Marshall and Hume ("Game Birds of India") state that they have only observed this secondary spur in domesticated birds.

eastern Asia, there are several limb-bones. A slightly imperfect right tibio-tarsus

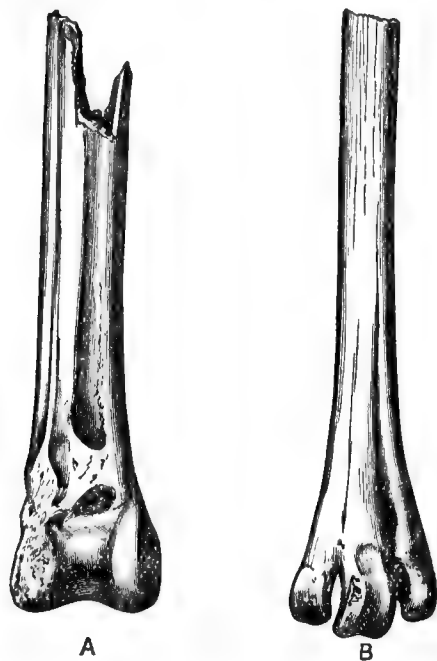


Fig 9. *Ibis melanocephala*. The distal portion of the right tibio-tarsus (A) and left tarso-metatarsus (B). †. The former is from bed Ca in the Cathedral, and the latter from the Purgatory cave. Indian Museum (Nos. F. 315a, 315b).

(No. F. 315) from bed Cd in the Cathedral agrees very closely with the corresponding bone of a skeleton in the British Museum, and measures 6·5 inches in length. The distal portion of a slightly larger specimen of the homologous bone from bed Ca in the same cave is represented in the accompanying woodcut (fig. 9), and shows the well-marked bridge over the channel of the extensor tendons. The distal half of the left tarso-metatarsus represented in the same woodcut was obtained from the Purgatory cave, and exhibits very clearly the trace of the divisions between the three component bones, which is very characteristic of the species.

#### IV. REPTILIA.

*General.*—Reptilian remains from the Karnul caves are, with the exception of those of *Varanus*, comparatively scarce, and in most cases even generically undeterminable. In addition to the genera noticed in the sequel, there is evidence of the existence of one or more small species of emydine, and perhaps also of other tortoises. Several fragments of jaws indicate small lizards probably belonging to the *Geckonidæ* and *Agamidæ*, but many of the specimens appear to be of very recent origin. There are also some small snakes, which have not been generically determined.

##### CROCODYLUS, sp.

*Tooth.*—This genus is represented by a small anterior tooth, probably belonging to the lower jaw, from bed Y in the Cathedral cave.<sup>1</sup>

##### VARANUS DRACÆNA (Shaw).

*Abundance of remains.*—Remains of *Varanus* are of exceedingly common occurrence in the Karnul caves, and consist mainly of upper and lower jaws and vertebræ. In the absence of any evidence to the contrary all these remains are referred to the common species now inhabiting southern India, which at the present day attains a length of four feet.

*Maxilla.*—A right maxilla from bed K in the Charnel-House is represented in

<sup>1</sup> See Foote "Rec. Geol. Surv. Ind." vol. XVII. p. 207.

woodcut fig. 10, and presents no characters by which it can be distinguished from the corresponding bone of full-sized individuals of the existing form.

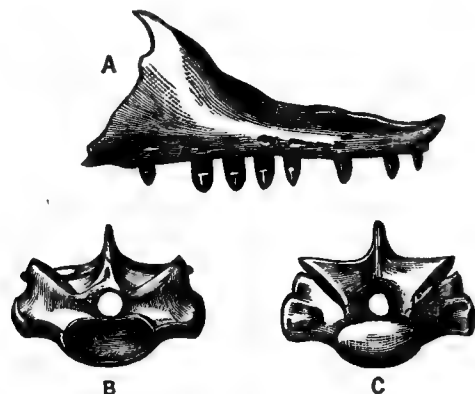


Fig. 10. *Varanus dracena*. The right maxilla (A), and a dorsal vertebra from the anterior (B) and posterior (C) aspects; from the Cathedral cave.  $\frac{1}{4}$ . Indian Museum (No. F. 334).

*Vertebra*.—In the same woodcut is represented a dorsal vertebra from bed *Ca* in the Cathedral cave agreeing in relative size with the maxilla; other specimens indicate somewhat larger individuals, which may have been as much as five feet in length.

*Siwalik species*.—In order to exhibit the enormous size attained by the Siwalik representative of the genus (*V. sivalensis*) an imperfect dorsal vertebra<sup>1</sup> from the Siwalik Hills is represented in woodcut fig. 11. The length of the centrum is 0·8



Fig. 11. *Varanus sivalensis*, Falconer. A dorsal vertebra; from the posterior and ventral aspects; from the pliocene of the Siwalik Hills.  $\frac{1}{4}$ . British Museum (No. R. 739).

inch. An imperfect cervical vertebra in the same collection (No. R. 740) indicates a still larger individual.

#### PYTHON MOLURUS (Linn.)

*Vertebrae*.—Several dorsal vertebrae indistinguishable from those of the existing

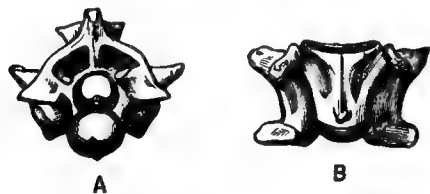


Fig. 12. *Python molurus*. A dorsal vertebra viewed from the posterior (A) and ventral (B) aspects; from the Cathedral cave (bed *Cb*).  $\frac{1}{4}$ . Indian Museum (No. F. 336).

form have been obtained from beds *Cb*, *Cc*, and *Cd* of the Cathedral. All these specimens (of which one is figured in the accompanying woodcut) belong to small individuals ranging from about seven to ten feet in length. The species has been provisionally recorded from the Siwaliks

<sup>1</sup> This and the next specimen were brought to light after the description of the humerus was published in vol. III. p. 236 of the present work.

of the Punjab.<sup>1</sup> The characteristic shortness of the centrum and the breadth and bluntness of the hæmal ridge, are well shown in the figure.

NAIA TRIPUDIANS (Merr.)

*Vertebra*.—A dorsal vertebra of a snake (No. F. 336b) from bed Cb in the Cathedral indicates the occurrence of *Naia tripudians* among the Karnul cave-fauna. This specimen agrees precisely with the dorsal vertebra of this species described and figured in Owen's "Monograph of the Reptiles of the London Clay," pt. II. p. 55, pl. XIII. figs. 13-16 (1850), where the distinctive features are clearly identified.

PTYAS MUCOSUS (Linn.)

*Vertebra*.—The dorsal vertebra of a large snake from bed Cb in the Cathedral

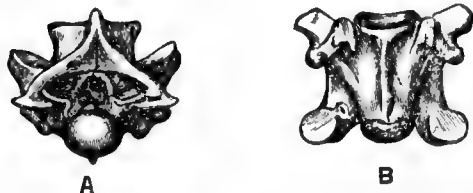


Fig. 13. *Ptyas mucosus*. A dorsal vertebra, viewed from the posterior (A) and ventral (B) aspects; from the Cathedral cave (bed Cb). †. Indian Museum (No. F. 336a).

represented in woodcut fig. 13 agrees so closely in structure with a vertebræ of a small example of the widely-distributed *Ptyas mucosus* in the British Museum,<sup>2</sup> that it may be safely referred to the same genus, and probably to the same species. The recent vertebra with which it was compared belonged to an individual between two and three feet

in length, but living examples are found of seven-and-a-half feet in length, and the fossil indicates an individual of perhaps somewhat larger dimensions. The characters distinguishing the vertebræ of the present genus from those of *Python* (fig. 12) are the longer centrum, the more strongly developed hæmal ridge, and the greater prominence of the articular facettes for the ribs.

V. AMPHIBIA.

BUFO (*cf.* MELANOSTICTUS, Schneider).

*Humerus*.—The only amphibian remains that have come under the writer's



Fig. 14. *Bufo* (*cf. melanostictus*). The imperfect left humerus; from the Cathedral cave (bed Cc). †. Indian Museum (No. F. 337).

notice<sup>3</sup> are several imperfect specimens of the humerus of a *Bufo* from beds Ob and Cc in the Cathedral. These specimens, of which one is represented in woodcut fig. 14, may probably be referred to the common *Bufo melanostictus*, which ranges over the whole of India, and many of the adjacent countries.

<sup>1</sup> *Supra*. vol. III. p. 237. pl. XXXV. fig. 4. The specimen represented in fig. 7 is a dorsal and not a caudal vertebra.

<sup>2</sup> The writer is indebted to Mr. G. A. Boulenger of the British Museum for having caused this specimen to be prepared for the purpose of comparison.

<sup>3</sup> Mr. Foote 'Rec. Geol. Surv. Ind.' vol. XVIII. p. 232 mentions the occurrence of *Rana*.

## VI. MOLLUSCA.

*General.*—For the determination of the very few shells obtained from the Karnul caves the writer is indebted to Mr. W. Theobald. The five species which have been determined are all found at the present day in the same region. Several of the shells still retain distinct traces of their colouration.

*Helicidae.*—Of *Helix* (including subgenera) there are three species, namely *H. (Ariophanta) cysis*, Benson, *H. (Hemiplecta) vitellina*, Pfeiffer, and *H. (Rotula) indica*, Pfeiffer; while *Bulimus* is represented by *B. (Cylindrus) insularis*,<sup>1</sup> Ehr. Specimens of the first three species have been obtained from beds *C* and *Ca* in the Cathedral, while the one specimen of the last is from the Charnel-House.

*Cyclostomidae.*—This family is represented by *Cyclophorus involutus* (Müll.), which appears commoner than any of the other species. Mr. Theobald remarks that the Karnul shells are not of the Ceylon type, but agree with the variety now found living at Midnapur, in Bengal.<sup>2</sup> Some of the fossil specimens were obtained from the Charnel-house and others from bed *Ca* in the Cathedral cave.

## ADDENDUM.

The following specimen was overlooked until the text was in type.

## HERPESTES NIPALENSIS, Gray.

*Mandible.*—The imperfect right mandibular ramus of a small species of *Herpestes*



Fig. 15. *Herpestes nipalensis*. The imperfect right ramus of the mandible; from the Cathedral cave (bed *Cb*). †. Indian Museum (No. F. 324).

from bed *Cb* in the Cathedral represented in the accompanying woodcut may be referred to the present species. The specimen shows the broken canine, the complete  $\overline{m.1}$ , and the alveoli of the other cheek-teeth. The specimen agrees precisely with the jaw of the existing race; the large size of the alveolus of  $\overline{pm.1}$  distinguishing it from the allied

African *H. gracilis*, in which this tooth is either wanting, or of much smaller size than in *H. nipalensis*.

*Distribution.*—At the present day the species occurs throughout the outer Himalaya, and also in the plains near the hills from the Punjab to Bengal, as well as in Assam, Burma, and the Malay Peninsula; the extension of its range during the pleistocene into southern India is paralleled by that of *Rhinoceros unicornis*.

<sup>1</sup> Syn. *Bulimus pullus*, Gray.

<sup>2</sup> Mr. Theobald says that the shell figured in Hanley and Theobald's "Conchologia Indica," pl. II. fig. 8 as from Midnapur does not represent the form obtained there by himself, which is the same as the fossil one.

## LIST OF THE FAUNA.

The following list comprises all the forms described in the preceding pages.

## MAMMALIA.

- PRIMATES. — *Semnopithecus entellus* (*Dufresne*).  
*Cynocephalus*, *sp.*  
 CARNIVORA. — *Felis tigris* (*or ? leo*) *Linn.*  
*? pardus*, *Linn.*  
*chaus*, *Güldenst.*  
*rubiginosa*, *Geoffr.*  
*Hyæna crocuta* (*Erxl.*).  
*Viverra karnuliensis*, *nobis.*  
*Prionodon* (?), *sp.*  
*Herpestes griseus*, *Desm.*  
*fuscus*, *Waterh.*  
*nipalensis*, *Gray.*  
*Ursus labiatus*, *Blainv.*  
 INSECTIVORA. — *Sorex*, *sp.*  
 CHIROPTERA. — *Taphozous saccolæmus*, *Temm.*  
*Phyllorhina diadema* (*Geoffr.*).  
 RODENTIA. — *Sciurus macrurus*, *Hardw.*  
*Gerbillus indicus* (*Hardw.*).  
*Nesokia bandicoota* (*Bech.*).  
*kok*, *Gray.*  
*Mus mettada* (*Gray*).  
*platythrix*, *Sykes.*  
*sp. var.*  
 RODENTIA. — *Golunda ellioti*, *Gray.*  
*Hystrix crassidens*, *nobis.*  
*Atherura karnuliensis*, *nobis.*  
*Lepus* (*cf. nigricollis*, *F. Cuv.*).  
 UNGULATA. — *Equus asinus*, *Linn.*  
*sp. a.*  
*Rhinoceros karnuliensis*, *nobis.*  
*Bos or Bubalus*, *sp.*  
*Boselaphus tragocamelus* (*Pall.*).  
*Genus non. det.*  
*Gazella bennetti* (*Sykes*).  
*Antilope cervicapra* (*Linn.*).  
*Tetracerus quadricornis* (*Blainv.*).  
*Cervus aristotelis*, *Cuv.*  
*axis*, *Erxl.*  
*? Cervulus muntjac* (*Zimm.*).  
*Tragulus* (*cf. meminna* [*Erxl.*]).  
*Sus cristatus*, *Wagner.*  
*karnuliensis*, *nobis.*  
 EDENTATA. — *Manis gigantea*, *Illiger.*

## AVES.

- ACCIPITRES. — *Neophron percnopterus* (*Linn.*).  
*? Milvus or Circus*, *sp.*  
*Ketupa ceylonensis* (*Gmelin*).  
*Bubo coromandus* (*Lath.*).  
 GALLINÆ. — *Francolinus pictus* (*Jard. and Selby*).  
*pondicerianus* (*Gmelin*).  
 ALECTORIDES. — *Grus* (*cf. communis*, *Bechst.*).  
 HERODIONES. — *Ibis melanocephala* (*Lath.*).

## REPTILIA.

- CROCODILIA. — *Crocodylus*, *sp.*  
 LACERTILIA. — *Varanus dracæna* (*Shaw.*).  
 OPHIDIA. — *Python molurus* (*Linn.*).  
 OPHIDIA. — *Naia tripudians* (*Merr.*).  
*Ptyas mucosus* (*Linn.*).

## AMPHIBIA.

- BATRACHIA. — *Bufo* (*cf. melanostictus*, *Shneid.*).

## MOLLUSCA.

- GASTROPODA. — *Helix cysis*, *Rens.*  
*vitellina*, *Pff.*  
*indica*, *Pff.*  
 GASTROPODA. — *Bulimus insularis*, *Ehr.*  
*Cyclophorus involutus* (*Müll.*).



## PLATE VII.

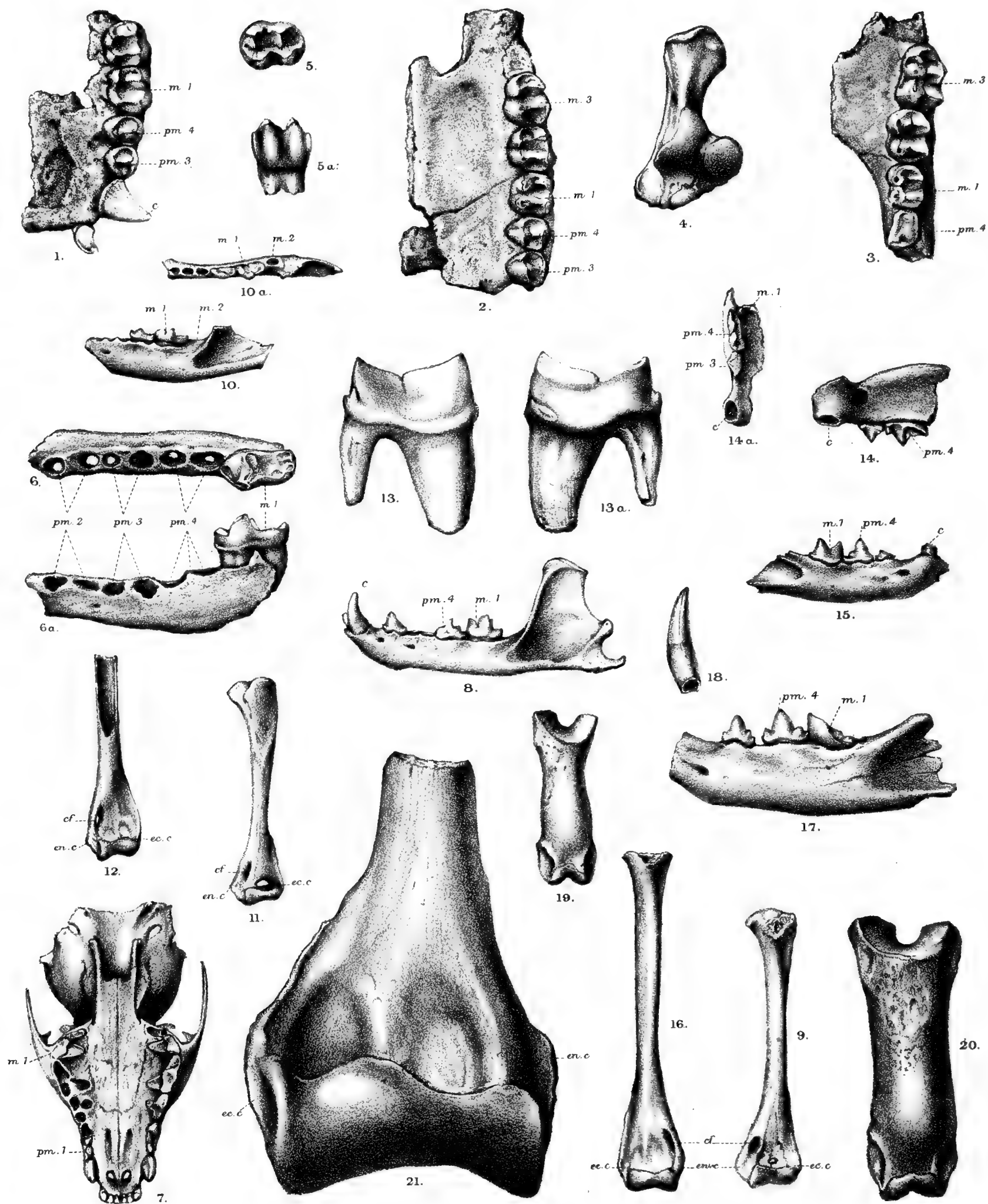
### PRIMATES AND CARNIVORA.

- Fig. 1. SEMNOPITHECUS ENTELLUS (Dufresne). Part of the right half of the palate of a female; from the Charnel-House cave (bed *A*). No. F. 201*a*.—Page 28.
- „ 2, 3. SEMNOPITHECUS ENTELLUS (Dufresne). Part of the right maxilla and mandibular ramus; from the Charnel-House cave (bed *M*). No. F. 201.—Page 28.
- „ 4. SEMNOPITHECUS ENTELLUS (Dufresne). The right calcaneum; from the Cathedral cave (bed *C*). No. F. 201*b*. Page 28.
- „ 5, 5*a*. CYNOCEPHALUS, sp. The second left lower true molar; from the Charnel-House cave (bed *M*). No. F. 202. Fig. 5*a* exhibits the outer aspect.—Page 28.
- „ 6. VIVERRA KARNULIENSIS, Lyd. Part of the left ramus of the mandible; from the Charnel-House cave (bed *L*). No. F. 227.—Page 31.
- „ 7. HERPESTES GRISEUS, Desm. The cranium; from the Cathedral cave (bed *Ch*, but probably of recent origin). No. F. 230.—Page 32.
- „ 8. HERPESTES GRISEUS, Desm. The left ramus of the mandible associated with the preceding specimen.
- „ 9. HERPESTES GRISEUS, Desm. The left humerus; from the Cathedral cave (bed *Ca*). No. F. 230*a*.—Page 33.
- „ 10, 10*a*. HERPESTES FUSCUS, Waterh. The left ramus of the mandible; from the Cathedral cave (bed *Cd*). No. F. 231.—Page 33.
- „ 11. HERPESTES FUSCUS, Waterh. The left humerus; from the Cathedral cave (bed *Ca*). No. F. 231*a*.—Page 33.
- „ 12. (?) PRIONODON, sp. The imperfect left humerus; from the Cathedral cave (bed *Cb*). No. F. 229*b*.—Page 32.
- „ 13, 13*a*. HYÆNA CROCUTA (Erxl.). The left lower carnassial, from the inner (13) and outer (13*a*) aspects; from the Cathedral cave (bed *Cb*). No. F. 222.—Page 30.
- „ 14, 14*a*. FELIS RUBIGINOSA, Geoffr. The imperfect left maxilla; from the Cathedral cave (bed *Ca*). No. F. 229.—Page 30.
- „ 15. FELIS RUBIGINOSA, Geoffr. The right ramus of the mandible; from the Cathedral cave (bed *Cb*). No. F. 229.—Page 30.
- „ 16. FELIS RUBIGINOSA, Geoffr. The right humerus; from the Cathedral cave (bed *Cc*). No. F. 229*a*.—Page 30.
- „ 17. FELIS CHAUS, Güldens. The left ramus of the mandible; from the Cathedral cave (bed *Ca*). No. F. 228.—Page 29.
- „ 18. FELIS CHAUS, Güldens. The left upper canine, from the inner aspect; from one of the Karnul caves. No. F. 228*a*.—Page 30.
- „ 19. (?) FELIS PARDUS, Linn. A first phalangeal; from the Cathedral cave (bed *Cc*). No. F. 225. Page 29.
- „ 20. FELIS TIGRIS (or ? LEO), Linn. The first phalangeal of the third digit of the pes; from the Purgatory cave. No. F. 224*a*.—Page 29.
- „ 21. URSUS LABIATUS, Blainv. The distal extremity of the right humerus; from the Chapter-House cave (bed *Ab*). No. F. 226.—Page 33.

---

\* All the specimens are in the Indian Museum, and are represented of the natural size. The humeri are all viewed from the palmar aspect, and the lateral views of the mandible are from the outer aspect. *c.f.* entepicondylar foramen; *ec. c.* ectepicondyle; *en. c.* entepicondyle,







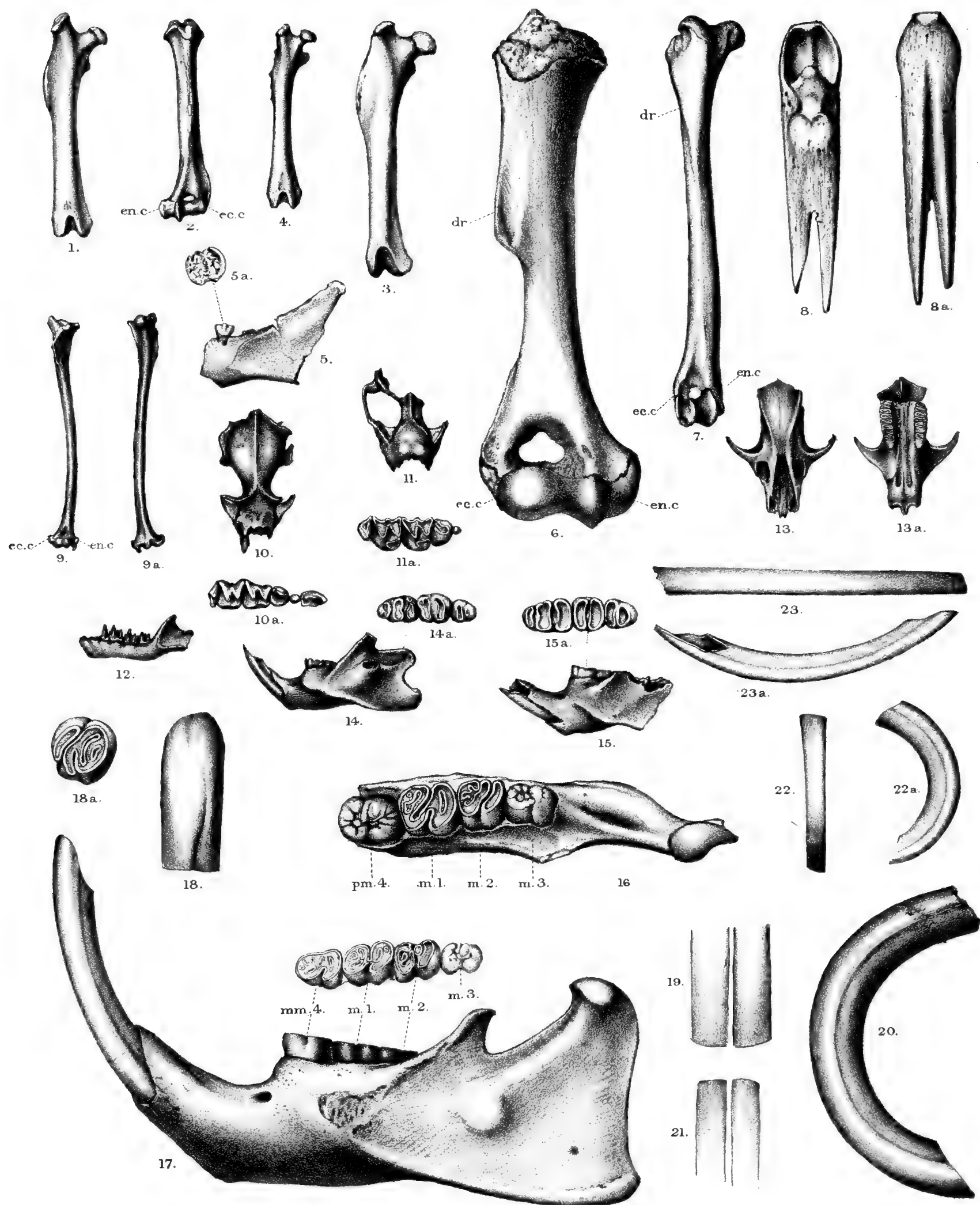


## PLATE VIII.

### CHIROPTERA, RODENTIA, AND EDENTATA.

- Fig. 1. ? NESOKIA BANDICOOTA, Bech. The right femur; from the Charnel-House. No. F. 344.—Page 35.
- „ 2. *Ibid.* The right humerus; from the Cathedral cave (bed *Ce*). No. F. 345.—Page 35.
- „ 3. *Ibid.* The imperfect right femur; from the Cathedral (bed *Cb*). No. F. 343.—Page 35.
- „ 4. ? NESOKIA KOK, Gray. The imperfect right femur; from the Charnel-House. No. F. 346.—Page 36.
- „ 5. SCIURUS MACRURUS, Hardw. Part of left ramus of the mandible; from the Cathedral (bed *Ca*). No. F. 217.—Page 34.
- „ 6. HYSTRIX CRASSIDENS, Lyd. The right humerus; from the Cathedral (bed *Cd*). No. F. 221.—Page 37.
- „ 7. LEPUS (*cf.* NIGRICOLLIS, F. Cuv.) The left humerus (reversed); from Purgatory cave. No. F. 218a.—Page 39.
- „ 8, 8a. MANIS GIGANTEA, Illig. The terminal phalangeal of the middle digit of the right manus; from the Cathedral cave (bed *Cc*). No. F. 232.—Page 50.
- „ 9, 9a. ? PHYLLORHINA DIADEMA (Geoffr.). The right humerus; from the Cathedral (bed *Cc*). No. F. 206a.—Page 34.
- „ 10, 10a. TAPHOZOUS SACCOLÆMUS, Temm. The imperfect cranium and right upper cheek-dentition; from the Cathedral cave (bed *Ci*). No. F. 209.—Page 34.
- „ 11, 11a. PHYLLORHINA DIADEMA (Geoffr.). The imperfect cranium and right upper cheek-dentition; from the Cathedral cave (bed *Ch*). No. F. 206.—Page 34.
- „ 12. *Ibid.* The left ramus of the mandible; from the Cathedral (bed *Ci*). No. F. 207.—Page 34.
- „ 13, 13a. NESOKIA KOK, Gray. The imperfect cranium; from the Cathedral (bed *Cb*). No. F. 213.—Page 35.
- „ 14, 14a. *Ibid.* The right ramus of the mandible and teeth (reversed); from the Cathedral (bed *Ch*). No. F. 214.—Page 36.
- „ 15, 15a. NESOKIA BANDICOOTA, Bech. The imperfect left ramus of the mandible and lower cheek-teeth; from the Charnel-House cave (bed *H*). No. F. 216.—Page 35.
- „ 16. HYSTRIX CRASSIDENS, Lyd. Part of the left ramus of the mandible; from the Cathedral (bed *C*). No. F. 219.—Page 37.
- „ 17, 17a. *Ibid.* The left ramus of the mandible and cheek-teeth; from the Cathedral (bed *Cd*). No. F. 219a.—Page 37.
- „ 18, 18a. *Ibid.* The right upper premolar; from the Cathedral (bed *Cd*). No. F. 220.—Page 37.
- „ 19. *Ibid.* Anterior aspect of the upper incisors; from the Cathedral (bed *Cd*). No. F. 220b.—Page 37.
- „ 20. *Ibid.* Outer aspect of left upper incisor; from the Cathedral (bed *Cd*). No. F. 220a.—Page 37.
- „ 21. *Ibid.* Part of the lower incisors, from the anterior aspect; from the Cathedral. No. F. 220c.—Page 37.
- „ 22, 22a. ATHERURA KARNULIENSIS, Lyd. Right upper incisor; from the Cathedral (bed *Cd*). No. F. 221a.—Page 38.
- „ 23, 23b. *Ibid.* Right lower incisor; from the Cathedral (bed *Cd*).—Page 38.

\* All the specimens are in the Indian Museum, and, with the exception of figs. 5a, 10a, 11a, 14a, 15a (which are  $\frac{2}{3}$ ) are represented of the natural size. The humeri, except fig. 9a, are viewed from the palmar aspect, and the lateral views of the mandibles are from the outer aspect. *dr.* deltoid ridge; *ec. c.* ectepicondyle; *en. c.* entepicondyle.









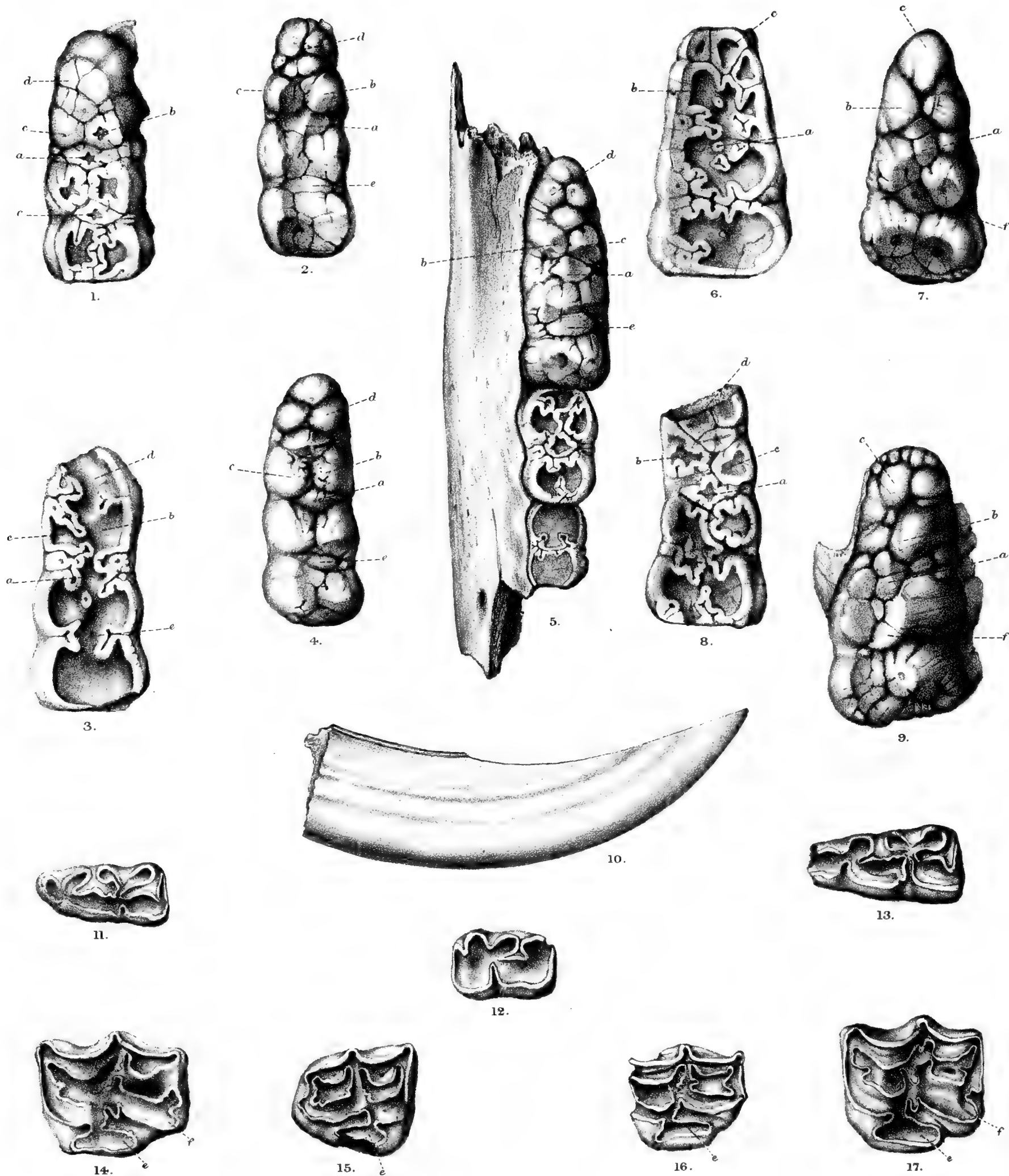
## PLATE IX.

### ARTIODACTYLA—*Suidæ*, AND PERISSODACTYLA—*Equidæ*.

- Fig. 1. *SUS CRISTATUS*, Wagner. The third left lower true molar; from the Cathedral cave (bed *Cc*) No. F. 266.—Page 47.
- „ 2. *SUS CRISTATUS*, Wagner. The third left lower true molar; from the Cathedral cave (bed *Cc*). No. F. 266a.—Page 47.
- „ 3. *SUS KARNULIENSIS*, Lyd. The third left lower true molar; from the Cathedral cave (bed *Cd*). No. F. 268.—Page 49.
- „ 4. *SUS CRISTATUS*, Wagner. The third left lower true molar; from the Cathedral cave (bed *Cb*). No. F. 267.—Page 47.
- „ 5. *SUS CRISTATUS*, Wagner. Part of the right ramus of the mandible; from a turbarry in Madras. No. F. 115.—Page 47.
- „ 6. *SUS KARNULIENSIS*, Lyd. The third right upper true molar; from the Cathedral cave (bed *Cd*). No. F. 260.—Page 49.
- „ 7. *SUS CRISTATUS*, Wagner. The third right upper true molar; from the Cathedral cave (bed *Cf*). No. F. 261.—Page 48.
- „ 8. *SUS KARNULIENSIS*, Lyd. The third right lower true molar; from the Cathedral cave (bed *Cb*). No. F. 267a.—Page 49.
- „ 9. *SUS KARNULIENSIS*, Lyd. The third left upper true molar; from the Cathedral cave (bed *Cd*). No. F. 260a.—Page 49.
- „ 10. *SUS CRISTATUS*, Wagner. Part of the left lower canine; from the Cathedral cave (bed *Ca*). No. F. 271.—Page 48.
- „ 11. *EQUUS ASINUS*, Linn. The third right lower true molar; from the Cathedral cave (bed *Cb*). No. F. 256.—Page 39.
- „ 12. *EQUUS ASINUS*, Linn. The first left lower true molar; from the Cathedral cave (bed *Ca*). No. F. 255.—Page 39.
- „ 13. *EQUUS*, *sp.* The third right lower true molar; from the Cathedral cave (bed *Cb*). No. F. 248.—Page 40.
- „ 14. *EQUUS*, *sp.* A left upper cheek-tooth; from the Cathedral cave (bed *Cc*). No. F. 246.—Page 39.
- „ 15. *EQUUS ASINUS*, Linn. The third right upper true molar; from the Cathedral cave (bed *Cf*). No. F. 254.—Page 39.
- „ 16. *EQUUS*, *sp.* The third left upper true molar; from the Cathedral cave (bed *Cd*). No. F. 253.—Page 39.
- „ 17. *EQUUS*, *sp.* A left upper cheek-tooth; from the Cathedral cave (bed *Cc*). No. F. 246a.—Page 39.

---

\* All the specimens are in the Indian Museum, and are represented of the natural size. Excepting fig. 10, which is from the inner aspect, all the specimens are viewed from the oral aspect. In the molars of *Sus* the letters *a* to *f* indicate the homologous elements of the upper and lower teeth; in those of *Equus* *e* indicates the antero-internal pillar.







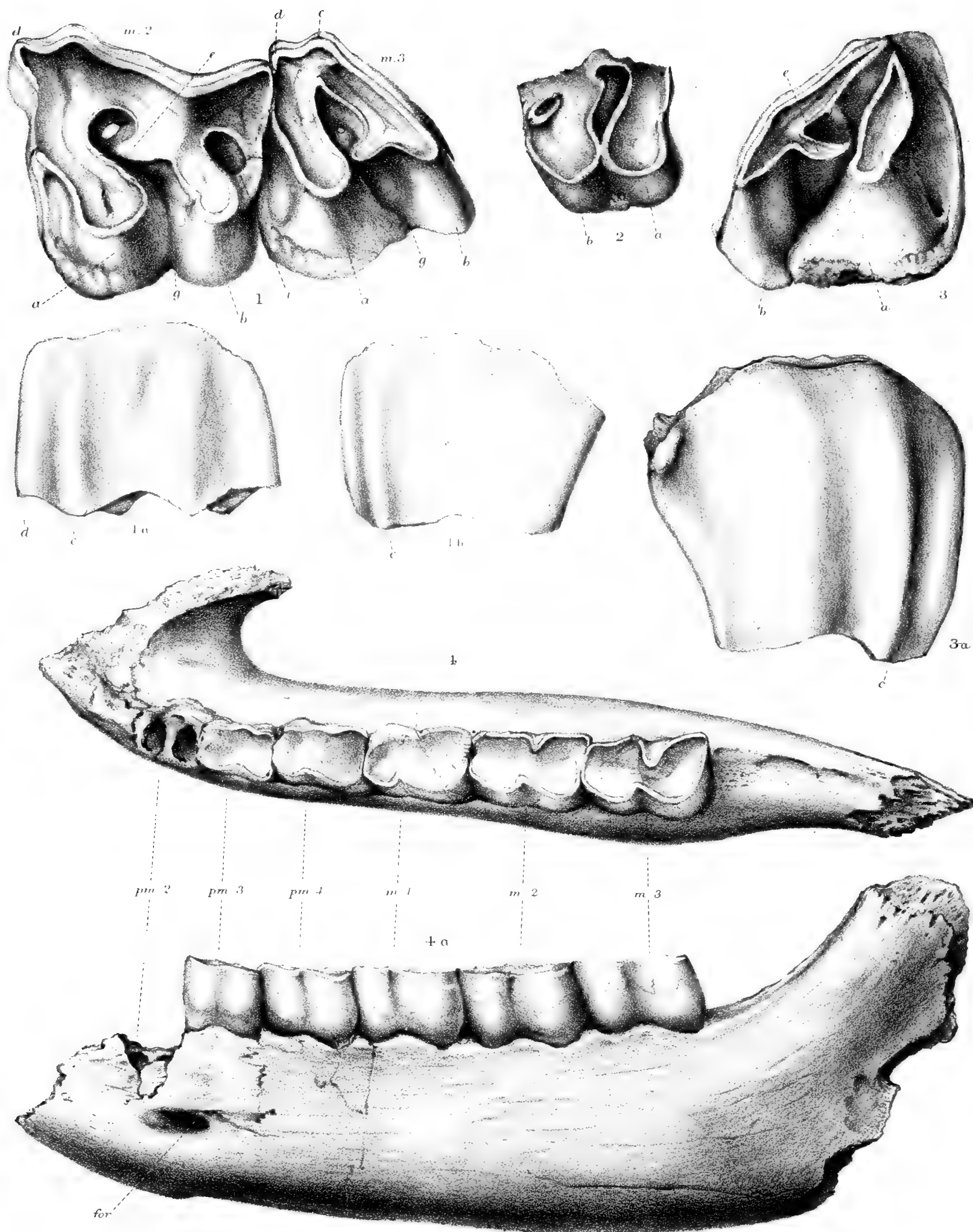
## PLATE X.

### PERISSODACTYLA.—*Rhinocerotidæ*.

- Figs. 1, 1a, 1b. RHINOCEROS KARNULIENSIS, Lyd. The second and third left upper true molars, in a middle stage of wear; from the Cathedral cave (bed Cc). No. F. 233. Fig. 1 shows the inner and grinding surfaces of the two teeth, fig. 1a the outer surface of m. 2, and fig. 1b that of m. 3.—Page 41.
- „ 2. RHINOCEROS KARNULIENSIS, Lyd. The inner half of the well-worn third right upper premolar; from the Cathedral cave (bed Cc). No. F. 236.—Page 42.
- „ 3, 3a. RHINOCEROS UNICORNIS, Linn. The third right upper true molar, in an early stage of wear; from a turbary in Madras. No. F. 114. Fig. 3 shows the inner and grinding surfaces, and fig. 3a the outer surface.—Page 42.
- „ 4, 4a. RHINOCEROS KARNULIENSIS, Lyd. Part of the symphysis and left ramus of the mandible; from the Cathedral cave (bed Cd). No. F. 237. Fig. 4 is from the oral, and fig. 4a from the external aspect.—Page 40.

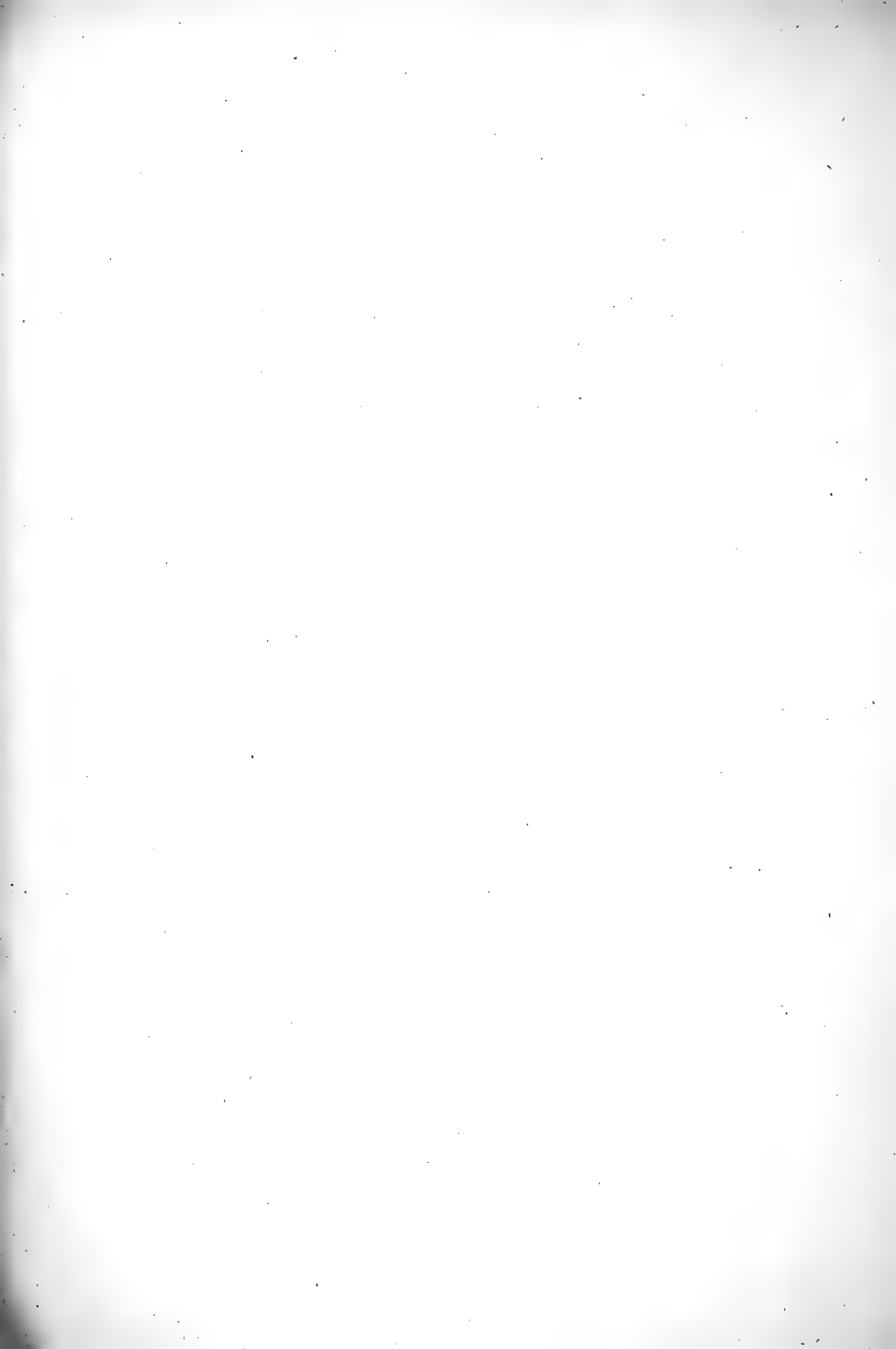
---

\* All the specimens are in the Indian Museum, and with the exception of figs. 4, 4a (which are  $\frac{1}{2}$ ) are represented of the natural size. *a*, anterior collis; *b*, posterior collis; *c*, second costa; *d*, first costa; *e*, crochet; *for*, mentary foramen; *g*, entrance of median valley; *i*, posterior valley.









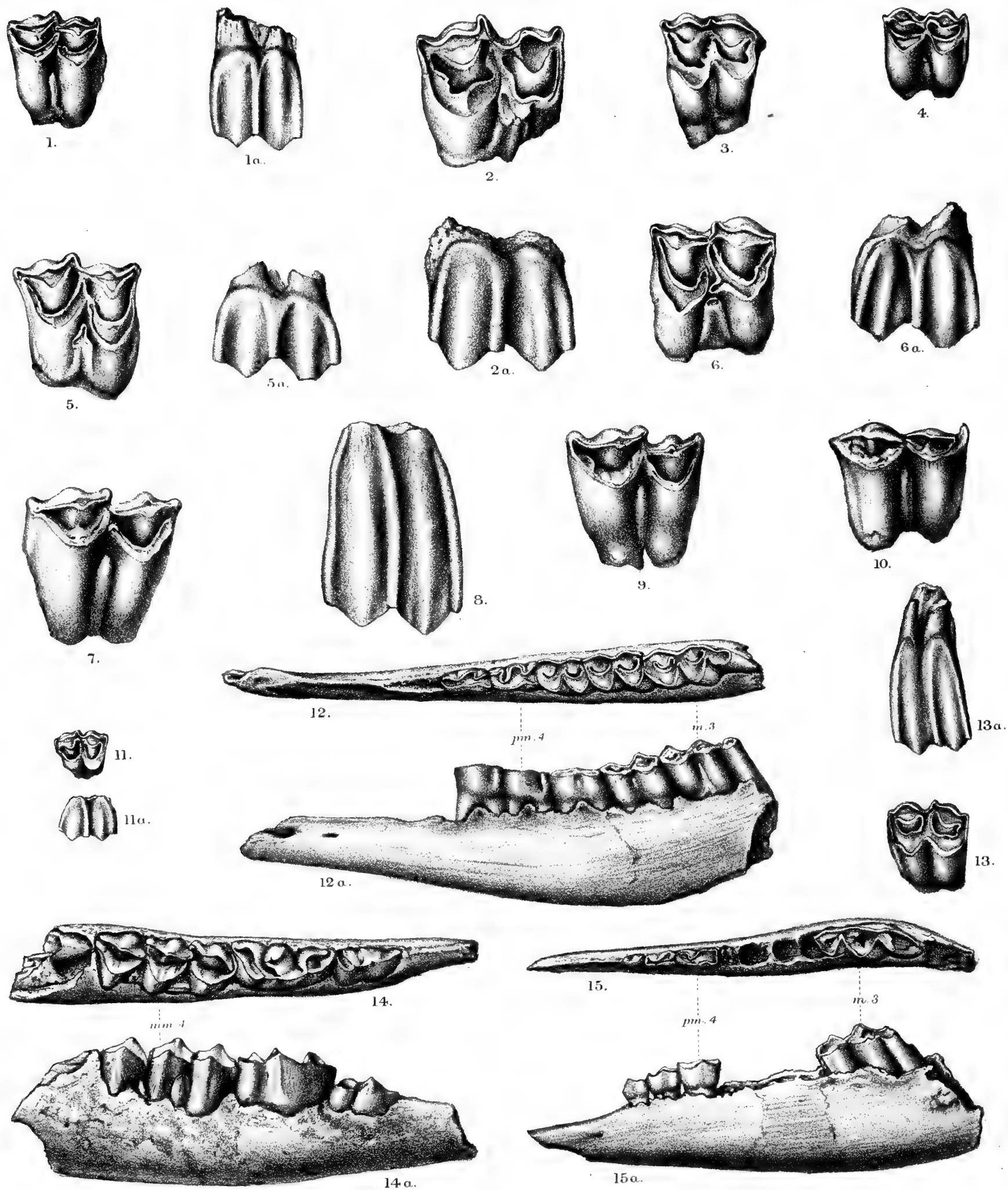
## PLATE XI.

### ARTIODACTYLA.—*Bovidæ and Cervidæ.*

- Fig. 1, 1a. CERVUS AXIS, Erxl. The third right upper true molar; from the Cathedral cave (bed Cc). No. F. 306.—Page 46.
- „ 2, 2a. ANTELOPE, *genus non. det.* The second right upper true molar; from the Cathedral cave (bed Cb). No. F. 288.—Page 45.
- „ 3. CERVUS AXIS, Erxl. The third left upper true molar; from the Cathedral cave (bed Cb). No. F. 306a.—Page 46.
- „ 4. CERVUS AXIS, Erxl. The first or second right lower true molar; from the Cathedral cave (bed Ce). No. F. 306b.—Page 47.
- „ 5, 5a. CERVUS ARISTOTELIS, Cuv. The first right upper true molar; from the Cathedral cave (bed Cf). No. F. 302.—Page 46.
- „ 6, 6a. CERVUS ARISTOTELIS, Cuv. The second left upper true molar; from the Cathedral cave (bed Cd). No. F. 302a. Page 46.
- „ 7. BOSELAPHUS TRAGOCAMELUS (Pall.). The first right upper true molar; from the Cathedral cave (bed Cd). No. F. 282.—Page 44.
- „ 8. BOSELAPHUS TRAGOCAMELUS (Pall.). The second right upper true molar; from the Cathedral cave (bed Ca). No. F. 280. Page 44.
- „ 9. BOSELAPHUS TRAGOCAMELUS (Pall.). The first right upper true molar; from the Cathedral cave (bed Cb). No. F. 281.—Page 44.
- „ 10. BOSELAPHUS TRAGOCAMELUS (Pall.). The second left lower true molar: from the Chapter-House cave (bed Aa). No. F. 284.—Page 44.
- „ 11, 11a.(?) CERVULUS MUNTJAC (Zimm.). The second right upper true molar; from the Purgatory cave. No. F. 308.—Page 47.
- „ 12, 12a. TETRACEROS QUADRICORNIS (Blainv.). The left ramus of the mandible; from the Cathedral cave (bed Cd). No. F. 277.—Page 46.
- „ 13, 13a. ANTILOPE CERVICAPRA (Linn.). The second left upper true molar; from the Cathedral cave (bed Cb). No. F. 287.—Page 45.
- „ 14, 14a. BOSELAPHUS TRAGOCAMELUS (Pall.). The right ramus of the mandible of a young individual; from the Karnul caves. No. F. 286.—Page 45,
- „ 15, 15a. GAZELLA BENNETTI (Sykes). The left ramus of the mandible; from the Cathedral cave (bed Ca). No. F. 278.—Page 45.

---

\* All the specimens are in the Indian Museum, and are represented of the natural size. In the text figs. 2, 5 and 6 are referred to the wrong side of the jaw.





MEMOIRS  
OF  
THE GEOLOGICAL SURVEY OF INDIA.

---

*Palæontologia Indica,*

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING  
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

---

Ser. X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. IV.

Part III. EOCENE CHELONIA FROM THE SALT-RANGE

by R. LYDEKKER, B.A., F.G.S., etc.

WITH 2 PLATES.

---

CALCUTTA:

SOLD AT THE

GEOLOGICAL SURVEY OFFICE, AND BY ALL BOOKSELLERS:

LONDON: TRÜBNER & CO.

MDCCLXXXVII.

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA, 5, MARTINS STREET, CALCUTTA.



QE736

I4

# INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

---

## EOCENE CHELONIANS FROM THE SALT-RANGE.

BY R. LYDEKKER, B.A., F.G.S., &c.

(WITH PLATES XII AND XIII.)

---

### INTRODUCTORY.

The two specimens, forming the subject of this memoir, were obtained in 1886 by Dr. H. Warth, by whom they were presented to the Indian Museum. They were both obtained at Nila (lat.  $32^{\circ} 29' 30''$ ; long.  $73^{\circ}$ ) in the Punjab Salt-Range; while at least the example of *Hemichelys* (Plate XII) came from a bed situated 10 feet below the coal-band of Nila.<sup>1</sup> From the same bed Dr. Warth also obtained certain other remains, which, according to a manuscript note by Dr. Waagen, with which the writer has been favoured, comprise teeth of *Lamna*, *Otodus*, and *Capitodus*, together with certain cephalopods allied to *Belemnites*; and Dr. Waagen is of opinion that the bed in question belongs to the highest horizon of the "*Cardita beaumonti* group," which is now regarded as a passage-bed between the cretaceous and the eocene, although in being more nearly allied by its fauna with the latter than with the former is provisionally classed as lowest eocene;<sup>2</sup> and may not improbably correspond homotaxially to the Cernayisian stage of Reims, and the Puerco group of the United States.

The fossils mentioned by Dr. Waagen indicate that the bed in which they were found is either of marine or estuarine origin; and this is confirmed by the Chelonians,

<sup>1</sup> See Wynne: 'Mem. Geol. Surv. Ind.' Vol. XIV, p. 168 (1878).

<sup>2</sup> See Blanford: 'Mem. Geol. Surv. Ind.' Vol. XX, pp. 4, 45, 46 (1883).



one of which is covered with the 'spat' of oysters, while sharks' teeth are embedded in the matrix of the other. The affinities of the Chelonians show, however, that their habitat could only have been estuarine, since they belong to essentially fresh-water families. Both specimens when placed in the hands of Mr. Barlow, of the British Museum, to be 'developed' were in a much broken condition, and from being traversed by numerous veins of calcspar, along which they readily split, it required all his skill to render them fit for description.

It should be mentioned that the only fossil Indian Chelonian from below the level of the Siwaliks (where all the forms are more or less closely allied to those now inhabiting India, and adjacent regions) which has been hitherto described is *Platemys leithi*<sup>1</sup> (Carter) from the intertrappeans (lower eocene) of Bombay, which is a small species with a shell of about five inches in length. *Platemys*, it need hardly be observed, is a member of the sub-order Pleurodira, now characteristic of the Southern Hemisphere, and is itself confined at the present day to South America. A chelonian has been recorded by Sir R. Owen<sup>2</sup> from the lower eocene of England under the name of *Platemys bowerbanki*, but Professor Rütimeyer<sup>3</sup> has shown that this generic determination is incorrect; and that the presence of an incomplete mesoplastral element in the plastron indicates affinity with the South American genera *Peltocephalus* or *Podocnemis*, although the imperfect preservation of the type specimen renders its precise determination a matter of considerable difficulty. The same authority also shows that the specimen figured by Owen<sup>4</sup> under the name of *Emys lævis*, Bell, is nothing more than the young of the above-mentioned species; and it may be added that the length of the band uniting the carapace with the plastron in this specimen is indicative of affinity with *Podocnemis* rather, than *Peltocephalus*, and it has been provisionally referred to the former genus by the present writer and Mr. G. A. Boulenger;<sup>5</sup> that genus being represented by another species in the same formation. A plastron, said to be from the London clay, was also referred by Sir R. Owen<sup>6</sup> to *Platemys*, under the name of *P. bullocki*; but this specimen is really from the Purbeck, and belongs to the genus *Pleurosternum*.<sup>7</sup>

It will suffice to add in the way of introduction that in the memoir on the Siwalik Chelonia published in Vol. III of the present work, the term 'scute' is applied to the bony framework of the Chelonian shell, and 'plate' to its horny epidermal covering; but, as this has been thought liable to lead to confusion the terms 'bone' and 'shield' are employed here in these senses.

<sup>1</sup> Originally described as *Testudo*, but referred by Gray to *Hydraspis*, which is now generally included in *Platemys*; see 'Rec. Geol. Surv. Ind.' Vol. XX, p. 66 (1887).

<sup>2</sup> Monograph of Reptilia of London Clay—Chelonia I, Pl. XXIII (1849).

<sup>3</sup> 'Ver. Nat. Ges. Basel,' Vol. VI, Art. 1, pp. 121, 128 (1878).

<sup>4</sup> *Op. cit.*, pl. XXII.

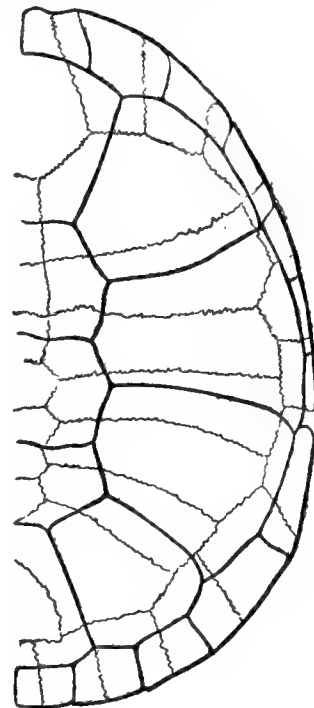
<sup>5</sup> Geological Magazine, June 1887.

<sup>6</sup> *Ibid.*, pl. XXI.

<sup>7</sup> See Lydekker and Boulenger, *op. cit.* Cope, 'Tertiary Vertebrata of the West' (Rep. U. S. Geol. Surv. TERS. Vol. III) book 1, p. III (1884), makes *Pleurosternum* the type of a distinct family of Cryptodira, and erroneously states that there is no intergular shield.

## Sub-order PLEURODIRA.

*Characters.*—The sub-order is characterised<sup>1</sup> by having the carapace and plastron fully ossified and united together; by the ankylosis of the pelvis to both plastron and carapace; by the absence of at least some of the vertebral bones;<sup>2</sup> and by the presence of only a single heart-shaped supra-pygial bone above the pygal, as is shown in the accompanying woodcut. Other characters are found in respect of the head and neck, which need not be mentioned on this occasion. When horny epidermal shields are present, an intergular shield is developed on the plastron; and a mesoplastral bone may be present. As additional characters of at least many genera, it may be observed that the nuchal bone (in the *Chelydidæ*) is smaller than the first vertebral shield, and that the suture between the pygal and supra-pygial bones is situated above the suture separating the pygal shields from the last vertebral shield (as is shown in the wood-cut); the reverse of these features obtaining very generally in the Cryptodira.<sup>3</sup> The sub-order may be divided into two families according to the presence or absence of horny shields on the shell.



The right half of the carapace of *Sternotherus subniger*, Gray; from Madagascar.

## Family CARETTOCHELYDIDÆ.

*History.*—This family was founded by Mr. Boulenger<sup>4</sup> on *Carettochelys insculptus*, Ramsay,<sup>5</sup> from the Fly River, New Guinea.

*Characters.*—The distinctive feature of the family is the absence of epidermal horny shields on both the carapace and plastron.

In *Carettochelys* the limbs are paddle-shaped, the anterior being much elongated; only the first and second digits are furnished with claws; the plastron is apparently composed of only the normal nine elements, the mesoplastron (intraplastron) being absent; the vertebral bones are of very small size, and are separated from one another by the meeting of the costals in the middle line, and the nuchal bone is greatly expanded laterally.

Genus HEMICHELYS, *nobis*.<sup>6</sup>

*Characters.*—Vertebral bones in contact, and not separated by the costals; a small mesoplastron apparently present.

<sup>1</sup> See Rütimeyer: 'Verh. Nat. Ges. Basel,' Vol. VI, Art. 1, pp. 21—33 (1878).

<sup>2</sup> The hinder vertebral bones are absent among the Cryptodira in *Cinosternum* and *Dermatemys*.

<sup>3</sup> Compare the figures in pls. XXI and XXIII of the preceding volume of this work.

<sup>4</sup> Ann. Mag. Nat. Hist. 1887, pp. 170—172.

<sup>5</sup> Proc. Linn. Soc., New South Wales, Vol. I, p. 158, pls. III—VI (1886).

<sup>6</sup> Rec. Geol. Surv. Ind., Vol. XX, p. 66 (1887).

HEMICHELYS WARTHI, *nobis*.<sup>1</sup>

*Characters*.—Carapace depressed, expanded posteriorly, with five vertebral bones, and its surface comparatively smooth; surface of plastron pitted; length of carapace about 28 inches.

*Description*.—The type specimen is represented in plate XII, and comprises the greater portion of the carapace and plastron. The former is tolerably perfect posteriorly, but has lost the greater portion of the lateral marginals, and anteriorly the nuchal bone, the marginals, and portions of the first costals; the figure is restored from the recent *Podocnemis pipiti* (Gray).<sup>2</sup> The plastron has lost both extremities, and its junction with the carapace is also injured.

When entire, the carapace must have measured about 28 inches in length. The Pleurodirian affinities of the specimen are conclusively shown by the general contour of the carapace, which agrees very closely with that of *Podocnemis pipiti*, by the presence of only five vertebral bones, and of a single supra-pygals, as well as by the elongated form of the pygal and adjacent marginal bones. The surface of the carapace is moderately smooth, and shows no trace of the marks of horny shields; the surface of the plastron (pl. XII, figs. 2, 3) is marked with small pits, and was evidently covered merely by skin. The only one of the plastral sutures that can be detected is that between the hyo- and hypo-plastron; externally this suture divides, apparently for the reception of a small incomplete mesoplastron.<sup>3</sup> Whether the extremity of the xiphiplastron was forked as in the restoration, or whether it was entire as in *Carettochelys*,<sup>4</sup> cannot of course be determined.

*Affinities*.—The absence of horny shields<sup>5</sup> from this interesting form conclusively separates it from all members of the *Chelydidae*, and affiliates it with *Carettochelys*. The latter is, however, widely distinguished by the characters of the vertebral bones<sup>6</sup> which form minute elongated hexagons, separated from one another by portions of the costals, which consequently meet in the middle line; the present form is also distinguished by the pitted sculpture on the plastron, and (apparently) the more deeply cut axillary notch; while it is highly probable that the nuchal bone was of the form represented in the restoration, and was not of the curiously expanded shape occurring in the New Guinea genus,<sup>7</sup> which resembles that of the *Trionychidae*.

These differences leave no doubt as to the generic distinction of the present form from *Carettochelys*, but the common feature of the absence of horny shields apparently indicates such relationship as to justify at least its provisional reference to the same family. While, however, *Carettochelys* is an extremely aberrant form

<sup>1</sup> *Loc. cit.*

<sup>2</sup> See 'Proc. Zool. Soc.,' 1871, pp. 747-48.

<sup>3</sup> Compare Owen's figure (*op. cit.*, pl. XXIII) of the so-called *Platemys bowerbanki*.

<sup>4</sup> Ramsay, *op. cit.*, pl. III.

<sup>5</sup> In the preliminary notice, I thought it probable that these plates were present on the carapace.

<sup>6</sup> Ramsay, *op. cit.*, pl. IV.

<sup>7</sup> *Ibid.*

not showing any close relationship to the *Chelydidæ*, *Hemichelys* appears to be much more nearly allied to that family, and may be the representative of a still earlier type from which the latter has been derived. The preservation of an apparently still more primitive type in the Australasian region is an instance analogous to that of the survival of *Ceratodus* and other primitive forms in the same area.

#### Family CHELYDIDÆ.

*Characters*.—Shell covered with horny epidermal shields, and an intergular shield present on the plastron.

There is considerable variation as to the number of vertebral bones in the carapace of the different genera. Thus, in the Australian genera *Chelodina*, *Chelymys*, *Euchelymys*, and *Elseya*, vertebrals are entirely absent, the only azygos bones being the nuchal, the supra-pygals, and the pygals.<sup>1</sup> In *Platemys* there are normally six such bones, but in *P. raniceps* the first three are wanting,<sup>2</sup> and in a specimen of *P. planiceps* in the British Museum there are none. In the eocene form figured by Owen<sup>3</sup> under the name of *Platemys bowerbanki* there are seven such bones; the same number being present in the existing genera *Podocnemis*, *Peltocephalus*, and *Sternothærus*<sup>4</sup> (woodcut). An incomplete mesoplastral element is present in *Podocnemis*, *Peltocephalus*, *Pelomedusa*, *Pentonyx*, and *Sternothærus*,<sup>5</sup> while in *Pleurosternum* this element is complete. *Peltocephalus* is distinguished from all the other genera by the fusion of the two pygals into a single shield, as in *Testudo*. The nuchal shield is wanting in *Sternothærus*, *Pelomedusa*, *Podocnemis*, and *Peltocephalus*.

Some writers regard the presence of a mesoplastral bone as a family character, and accordingly apply the name *Pelomedusidæ* to the group presenting this feature.

#### Genus PODOCNEMIS, Wagler.<sup>6</sup>

*Characters*.—Shell thick, with a long plastro-costal symphysis; nuchal shield absent; plastron solid; vertebral bones seven in number, the first five being elongated, and the seventh small, rhomboidal, and wedged in between the sixth and seventh costals.<sup>7</sup>

#### PODOCNEMIS INDICA, n. sp. *nobis*.

*Characters*.—Carapace oval, tectiform, not keeled, and narrowed posteriorly; the first vertebral shield wide, the second and third elongate, total length about 35 inches.

<sup>1</sup> Rütimeyer, *op. cit.*, p. 24.

<sup>2</sup> *Ibid.*

<sup>3</sup> *Op. cit.*, pl. XXIII.

<sup>4</sup> Rütimeyer, *op. cit.*, p. 24.

<sup>5</sup> Rütimeyer, *op. cit.*, p. 23.

<sup>6</sup> Syst. Amphibien, p. 135 (1830).

<sup>7</sup> Rütimeyer, *op. cit.*, p. 24.

*Description.*—The specimen on which this species is founded is represented in plate XIII. The greater portion of the carapace remains, but a large part of the right side and the whole of the posterior extremity are wanting; the vertebral and costal bones are distinctly defined, as are the boundaries of the anterior marginal and first three vertebral horny shields. Only small fragments of the plastron are preserved, although sufficient remains to show that this was united by bone with the carapace, and that the band of union was a comparatively long one. When complete the total length of the carapace must have been about thirty-five inches.

In the epidermal shields the most noticeable point is the absence of the nuchal; the first vertebral is wider transversely than it is long; while the second and third are imperfectly hexagonal, and are elongated antero-posteriorly. In the underlying bones the nuchal is of comparatively small size, and lies well within the limits of the first vertebral shield. There are seven vertebral bones, of which the first five are elongated, while the seventh is very small, and wedged in between the sixth and seventh costals. Behind the last vertebral the seventh and eighth costals unite in the median line; behind which there is the commencement of the supra-pygals bone, of which the hinder half is wanting. The contour of the carapace is sub-oval, the posterior portion being the narrowest; and the median line is much elevated, with the costals sloping rapidly away on either side: there is no keel on any of the vertebral bones.

*Affinities.*—It is quite clear from the general structure of the specimen that the only families to which it could possibly belong are the typical *Emydidae* or the *Chelydidae*; and it is extremely unfortunate that the decisive evidence which would be afforded by the plastron is not available. The characters of the carapace are, however, such as to indicate clearly that it is to the latter family to which it should be referred. In the first place, the nuchal bone is of the relatively small size characteristic of the *Chelydidae*; and in the second, the vertebral bones agree precisely in number and character with those of the *Podocnemis* group; while there is the same interval between the last vertebral and the supra-pygals bones, and the latter was evidently a single one. If indeed the figure of the Indian specimen be compared with that of the so-called *Platemys bowerbanki* given by Owen<sup>1</sup> (which, as we have already mentioned, is referred to *Podocnemis*), it will be seen that the two evidently belong to the same group, and might perfectly well be generically identical, although their specific distinctness is indicated by the wider vertebral epidermal shields of the English form. If again the figure of the present specimen be compared with that of *Podocnemis dumeriliana* given by Gray,<sup>2</sup> an equally striking resemblance will be observed in the general contour of the carapace, as well as in the absence of a nuchal shield; and there accordingly appears no doubt but that the specimen belongs to the *Chelydidae*. With regard to its generic position, the presence of seven vertebral bones differentiates it from all the existing Australian genera;

<sup>1</sup> *Op. cit.*, pl. XXIII.

<sup>2</sup> Cat. Shield-Reptiles in British Museum, pt. I, pl. XXVIII (1855).

while the absence of a nuchal shield affiliates it with the existing *Sternothærus*, *Pelomedusa*, *Podocnemis*, and *Peltocephalus*. From the first (woodcut, p. 61) it is readily distinguished by the much longer vertebral bones. By the unfortunate absence of the pygal region and the greater part of the plastron, the best distinctive characters of several of these genera are not available. *Podocnemis* is, however, distinguished from the others by the great length of the band uniting the plastron with the carapace, and its thick shell; in both of which respects the fossil agrees with it. *Podocnemis* contains, moreover, the largest living member of the family; and both the young of *P. expansa* and the adult of *P. dumeriliana* are characterised by their tectiform carapace; in which respect they also agree with the fossil. The close resemblance in the general contour of the fossil carapace and that of the latter species has been already alluded to, and since I can find no points of generic distinction between the former and the existing species of *Podocnemis*, I think the fossil may be at least provisionally referred to that genus<sup>1</sup> with the name of *P. indica*.

*Podocnemis*, it need scarcely be observed, is at the present day confined to South America; but its occurrence, together with that of *Platemys*, in the lower eocene of Western India, and also in the corresponding formation of England, indicates that the original home of this group of fresh-water Chelonians was in the northern hemisphere of the Old World, from which they have been driven in all probability by the competition of the *Emydidæ* to find a home in the southern half of America.

<sup>1</sup> I have not been able to compare the fossil with a recent *Podocnemis* in which the horny shields have been stripped from the carapace.



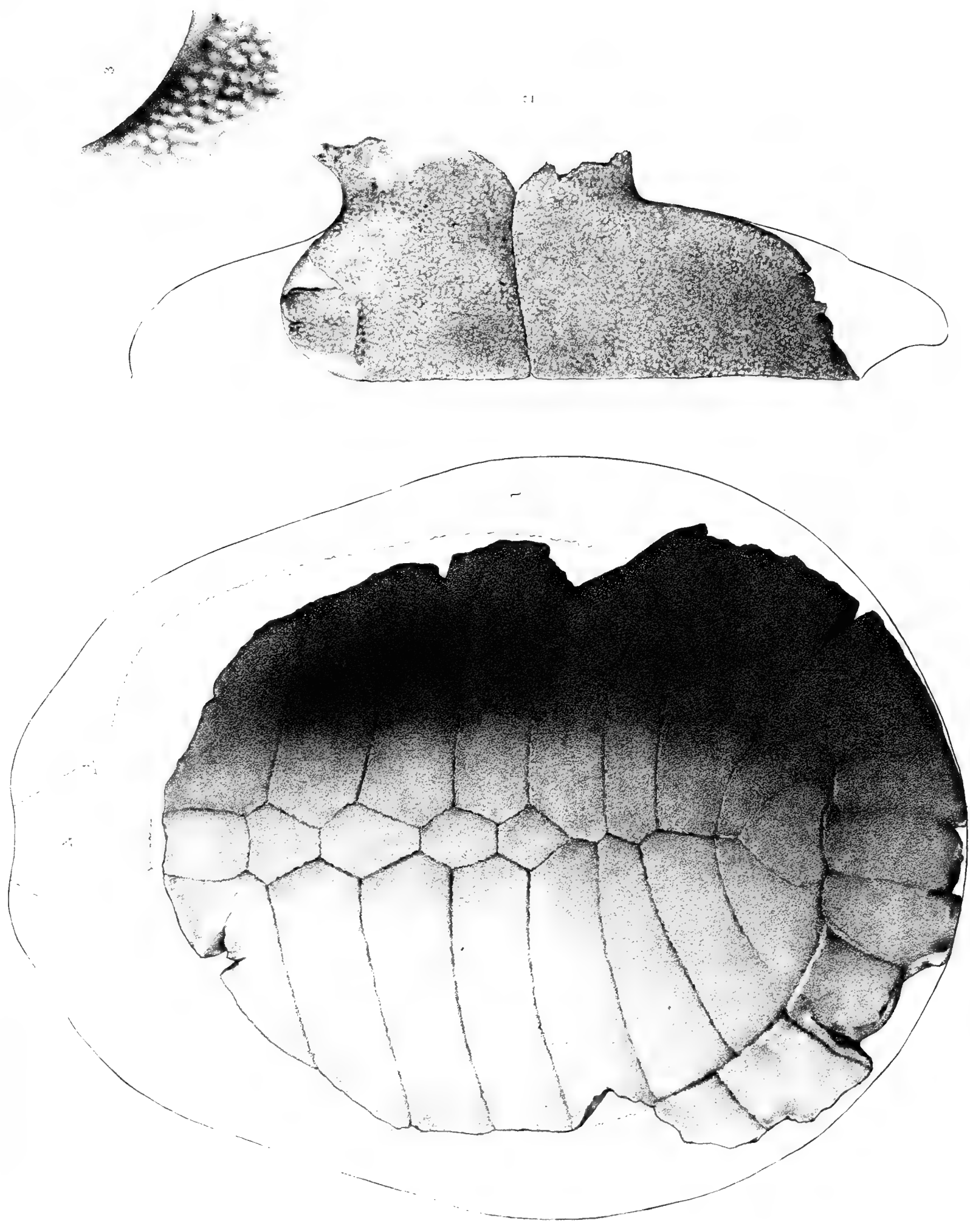




## PLATE XII.

### CHELONIA.

**HEMICHELYS WARTHI**, Lydekker; fig. 1 the carapace, fig. 2 the left half of the plastron, fig. 3 sculpture of the plastron; from the lower eocene of Nila, Salt-Range. Indian Museum. Figs. 1, 2,  $\frac{1}{4}$  nat. size; fig. 3 nat. size. *N.* nuchal bone. Page 62.



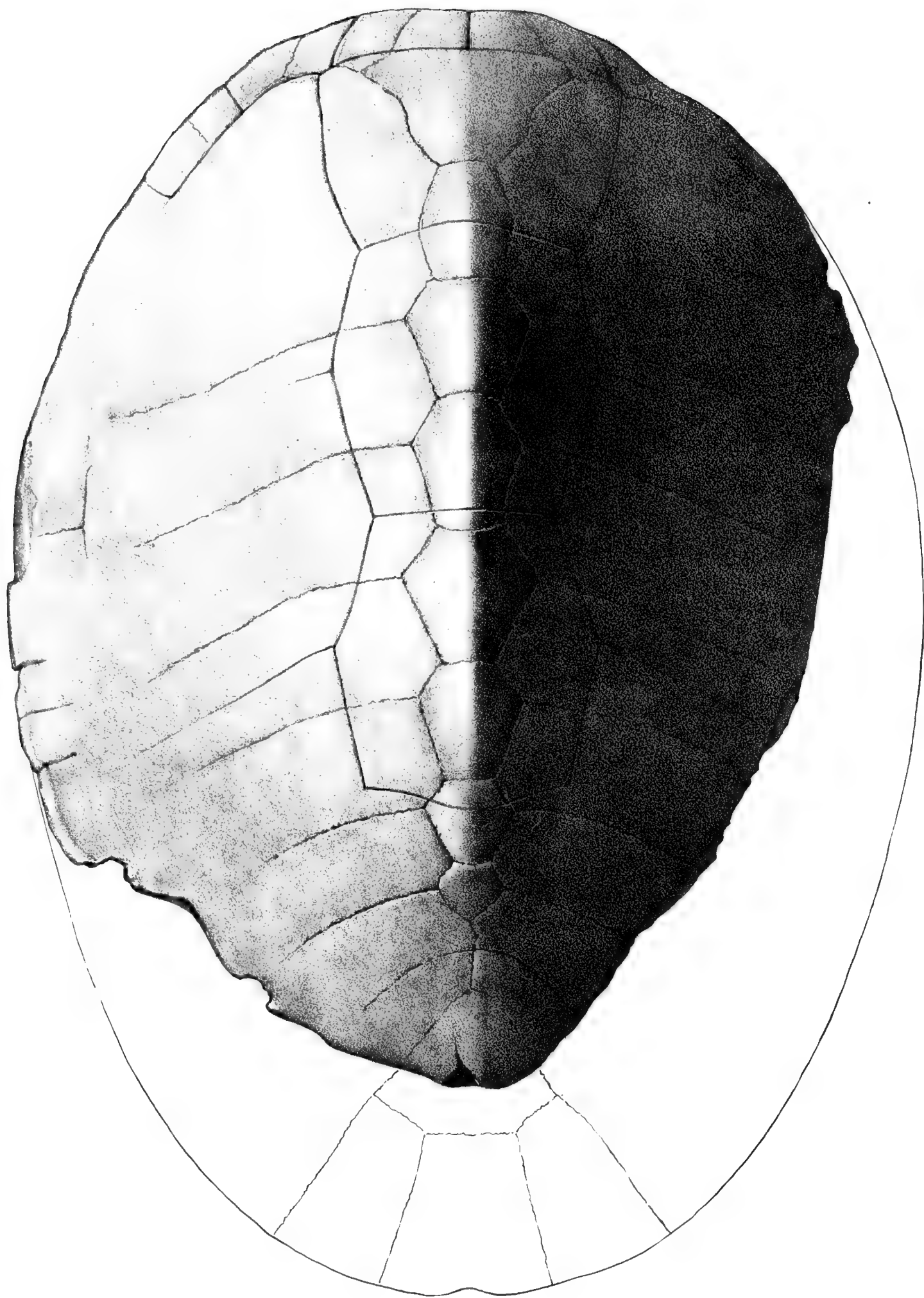




## PLATE XIII.

### CHELONIA.

PODOCNEMIS INDICA, Lydekker ; the carapace ; from the lower eocene of Nila, Salt-Range. Indian Museum.  $\frac{1}{4}$  nat. size. Page 63.







#### ERRATA TO PART II.

In list of Aves on pp. 51 and 58, before *Ketupa*, add STRIGES.

Page 57.—The *Helix* mentioned under the name of *H. cysis* turns out to be *H. nicobarica*; while that referred to as *H. indica* is more probably *H. ligulata*.



# PALÆONTOLOGIA INDICA.

(IN ROYAL 4to.)

(SER. I, III, V, VI, VIII.)—CRETACEOUS FAUNA OF SOUTHERN INDIA, by F. STOLICZKA, *except*  
Vol. I, Pt. I, by H. F. BLANFORD.

- VOL. I. The Cephalopoda (1861-65), pp. 216, pls. 94 (6 double).  
II. The Gastropoda (1867-68), pp. xlii, 500, pls. 28.  
III. The Pelecypoda (1870-71), pp. xxii, 537, pls. 50.  
IV. The Brachiopoda, Ciliopoda, Echinodermata, Corals, &c. (1872-79), pp. v, 202, pls. 29.

(SER. II, XI, XII.)—THE FOSSIL FLORA OF THE GONDWANA SYSTEM, by O. FEISTMANTEL, *except*  
Vol. I, Pt. I, by T. OLDHAM and J. MORRIS.

- VOL. I. pp. xviii, 233, pls. 72 (1863-79). Pt. 1. Rájmahál Group, Rájmahál Hills. Pt. 2. *Same continued*. Pt. 3. Plants from Golapilli. Pt. 4. Outliers on the Madras Coast.  
II. pp. xli, 115, pls. 26 (1876-78). Pt. 1. Jurassic Flora of Kach. Pt. 2. Flora of the Jabalpur Group.  
III. pp. xi, 64 x 149, pls. 80 (9 double) (I-XXXI x I A-XLVIIA). 1879-81. Pt. 1. The Flora of the Talchir-Karharbári beds. Pt. 2. The Flora of the Damuda and Panchet Divisions, Pt. 3. *The same (concluded)*.  
IV. pt. I (1882). Fossil Flora of the South Rewah Gondwana basin, by O. FEISTMANTEL, pp. 42, pls. 21.

(SER. IX.)—JURASSIC FAUNA OF KACH.

- VOL. I, (1873-76). The Cephalopoda, by W. WAAGEN, pp. i, 247, pls. 60 (6 double).

(SER. IV.)—INDIAN PRETERTIARY VERTEBRATA.

- VOL. I. pp. vi, 137, pls. 25, 1866-85. Pt. 1 (1865). The Vertebrate Fossils from the Panchet Rocks, by T. H. HUXLEY. Pt. 2 (1878). The Vertebrate Fossils of the Kota-Maleri Group, by Sir P. de M. GREY EGERTON and L. C. MALL. Pt. 3 (1879). Reptilia and Batrachia by R. LYDEKKER. Pt. 4 (1885). The Labyrinthodont from the Bijori Group, by R. LYDEKKER. Pt. 5 (1885). The Reptilia and Amphibia of the Maleri and Denwa groups, by R. LYDEKKER.

(SER. X.)—INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA, by R. LYDEKKER, *except* Vol. I, Pt. I, by R. B. FOOTE.

- VOL. I. pp. xxx, 300, pls. 50, 1874-80. Pt. 1. Rhinoceros Deccanensis. Pt. 2. Molar teeth and other Remains of Mammalia. Pt. 3. Crania of Ruminants. Pt. 4. Supplement to pt. 3. Pt. 5. Siwalik and Narbada Proboscidea.  
II. pp. xv, 363, pls. 45, 1881-84. Pt. 1. Siwalik Rhinocerotidae. Pt. 2. Supplement to Siwalik and Narbada Proboscidea. Pt. 3. Siwalik and Narbada Equidae. Pt. 4. Siwalik Camelopardalidae. Pt. 5. Siwalik Selenodont Suina, etc. Pt. 6. Siwalik and Narbada Carnivora.  
III. pp. xxiv, 264, plates 37, 1884-86. Pt. 1. Additional Siwalik Perissodactyla and Proboscidea. Pt. 2. Siwalik and Narbada Bunodont Suina. Pt. 3. Rodents and New Ruminants from the Siwaliks, and Synopsis of Mammalia. Pt. 4. Siwalik Birds. Pt. 5. Mastodon Teeth from Perim Island. Pt. 6. Siwalik and Narbada Chelonia. Pt. 7. Siwalik Crocodilia, Lacertilia, and Ophidia. Pt. 8. Tertiary Fishes.  
IV. pt. 1, pp. 18, pls. 6. Siwalik Mammalia—Supplement I.

(SER. VII, XIV.)—TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA.

- VOL. I. pt. 1 (1871). Tertiary Crabs from Sind and Kutch, by F. STOLICZKA, pp. 16, pls. 5. Pt. 1 (new 2) (1880). Sind Fossil Corals and Alcyonaria, by P. MARTIN DUNCAN, pp. 110, pls. 28. Pt. 3. The Fossil Echinoidea of Sind, by P. MARTIN DUNCAN and W. PERCY SLADEN, *Fas.* 1 (1882). The *Cardita beaumonti* beds, pp. 20, pls. 4. *Fas.* 2 (1882). The Ranikot series, pp. 80, pls. 16. *Fas.* 3 (1884). The Khirtar series, pp. 146, pls. 18. *Fas.* 4 (1884). The Nari series, pp. 26, pls. 5. *Fas.* 5 (1885). The Gáj series, pp. 94, pls. 12. Pt. 4 (1883). The Fossil Echinoidea of Kachh and Kattywar, by P. MARTIN DUNCAN and W. PERCY SLADEN, pp. 91, pls. 13.

(SER. XIII.)—SALT-RANGE FOSSILS by WILLIAM WAAGEN.

- VOL. I. Productus-Limestone Group. Pt. 1 (1879). Pisces, Cephalopoda, pp. 72, pls. 6. Pt. 2 (1880). Gastropoda and supplement to pt. 1, pp. 111 (73-183), pls. 10 (vii-xvi). Pt. 3 (1881). Pelecypoda, pp. 144 (185-328); pls. 8 (xvii-xxiv). Pt. 4 (1884). Brachiopoda, pp. 442 (329-770), pls. 62 (xxv-lxxxvi). Pt. 5 (1885). Bryozoa, Annelida, Echinodermata, pp. 64 (771-834), pls. 10 (lxxxvii-xcvi).

*The price fixed for these publications is 4 annas (6 pence) per single plate.*

To be had at the Geological Survey Office, Indian Museum, Calcutta; or through any Bookseller. London: Trübner & Co.

# MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

(In ROYAL 8vo.)

- VOL. I, pp. 309, 1859 (*out of print*).  
 „ II, pp. 341, 1859 (*out of print*).  
 „ III, pp. 438. Pt. I, (1863) (*out of print*). Pt. 2, 1864 (2 Rs.): On the Sub-Himalayan Ranges between the Ganges and Sutlej.  
 „ IV, pp. 450. Pt. 1, 1863 (2 Rs.): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (2 Rs.): On the Structure of the Districts of Trichinopoly, Salem, &c. Pt. 3, 1865 (1 Re.): On the Coal of Assam, &c.  
 „ V, pp. 354. Pt. 1, 1865 (3 Rs.): Sections across N. W. Himalaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (1 Re.): on the Geology of Bombay. Pt. 3, 1866 (1 Re.): On the Jherria Coal-field.—Geological Observations in Western Tibet.  
 „ VI, pp. 395. Pt. 1, 1867 (8 As.): On the neighbourhood of Lyayon, &c., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (2 Rs.): Bokaro Coal-field—Rāngarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (2 Rs. 8 As.): Taptee and Nerbudda Valleys.—Frog beds in Bombay.—*Oryglossus pusillus*.  
 „ VII, pp. 342. Pt. 1, 1869 (3 Rs.): Vindhyan Series.—Mineral Statistics.—Coal.—Shillong Plateau. Pt. 2, 1870 (1 Re.): Karharbāri Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (1 Re.): Aden Water-supply.—Kāranpura Coal-fields.  
 „ VIII, pp. 353. Pt. 1, 1872 (4 Rs.): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (1 Re.): Itkhuri Coal-field.—Daltonganj Coal-field.—Chobe Coal-field.  
 „ IX, pp. iv. 358. Pt. 1, 1872 (4 Rs.): Geology of Kutch. Pt. 2, 1872 (1 Re.): Geology of Nagpūr.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.  
 „ X, pp. 359. Pt. 1, 1873 (3 Rs.): Geology of Madras.—Sātpūra Coal-basin. Pt. 2, 1874 (2 Rs.): Geology of Pegu.  
 „ XI, pp. 338. Pt. 1, 1874 (2 Rs.): Geology of Dārjiling and Western Dúars. Pt. 2, 1876 (3 Rs.): Salt-region of Kohāt, Trans-Indus, pp. 330.  
 „ XII, pp. 363. Pt. 1, 1877 (3 Rs.): South Mahrātta Country. Pt. 2, 1876 (3 Rs.): Coal-fields of the Nāga Hills, pp. 95.  
 „ XIII, pp. 248. Pt. 1, 1877 (2 Rs. 8 As.): Wardha Valley Coal-field. Pt. 2, 1877 (2 Rs. 8 As.): Geology of the Rājmahāl Hills.  
 „ XIV, pp. 313. Geology of the Salt-range in the Punjab.  
 „ XV, pp. 192. Pt. 1, 1878 (2 Rs. 8 As.): Geology of the Aurunga and Hutār Coal-fields (Palamow). Pt. 2, 1880 (2 Rs. 8 As.): Ramkola and Tatapani Coal-fields (Sirgūja).  
 „ XVI, pp. 264. Pt. 1, 1879 (1 Re. 8 As.): Geology of Eastern Coast from Lat. 15° to Masulipitam. Pt. 2, 1880 (1 Re. 8 As.): The Nellore Portion of the Carnatic. Pt. 3, 1880 (2 Rs.): Coastal Region of the Godāvāri District.  
 „ XVII, pp. 305. Pt. 1, 1879 (3 Rs.): Geology of Western Sind. Pt. 2, 1880 (2 Rs.): Trans-Indus extension of the Punjab Salt-range.  
 „ XVIII, pp. 311. Pt. 1, 1881 (2 Rs.): Southern Afghanistan. Pt. 2, 1881 (1 Re. 8 As.): Mānbhūm and Singbhūm. Pt. 3, 1881 (2 Rs.): Prānhita-Godaveri Valley.  
 „ XIX, pp. 242. Pt. 1, 1882 (2 Rs.): The Cachar Earthquake of 1869. Pt. 2, 1882 (1 Re.): Thermal Springs of India. Pt. 3, 1883 (1 Re.): A Catalogue of Indian Earthquakes. Pt. 4, 1883 (1 Re.): Geology of parts of Manipur and the Nāga Hills.  
 „ XX, pp. 240. Pt. 1, 1883 (2 Rs. 8 As.): Geology of Madura and Tinnevely. Pt. 2, 1883 (2 Rs. 8 As.): Geological Notes on the Hills in the Neighbourhood of the Sind and Punjab Frontier between Quettah and Dera Ghazi Khan.  
 „ XXI, Pt. I, 1884 (2 Rs.): Geology of the Lower Narbada Valley between Nimawar and Kawant. Pt. 2, 1884 (1 Re.): Geology of the Kathiawar Peninsula in Guzerat.  
 „ XXII, pp. 344 (1883): The Geology of Kāshmir, Chamba, and Khāgān.

*The price fixed for these publications is 5 Rs. (10s.) each volume.*

Manual of the Geology of India, 2 Vols. and Map (*out of print*). Pt. III. (Economic Geology), 1881, price 5 Rs. (10s.).

To be had at the Geological Survey Office, Indian Museum, Calcutta; or through any Bookseller. London: Trübner & Co.

## RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

(In ROYAL 8vo.)

The RECORDS OF THE GEOLOGICAL SURVEY OF INDIA will be issued at intervals of about three months (February, May, August, and November), and forwarded to subscribers.

The annual subscription for four numbers is 2 Rs. (4s.). Postage additional, if forwarded, for India, 4 As., for Great Britain 8 As. (1s.).

Each number will contain the additions to the Library and donations to the Museum up to the first of the next preceding month,—that is, to the end of March, June, September, and December. The first volume (1868) contains only three numbers.

CALCUTTA, October, 1886.



# MEMOIRS OF THE GEOLOGICAL SURVEY OF INDIA.

- VOL. I. Royal 8vo, pp. 309, 1859. Pt. 1 (*out of print*): On the Coal and Iron of Cuttack.—Structure and Relations of the Tálchir Coal-field.—Gold Deposits in Upper Assam.—Gold and Gold-dust from Shne-Gween. Pt. 2 (*out of print*): Geology of the Khasi Hills.—The Nilghiri Hills. Pt. 3 (*out of print*): Geology of Bankoorah, Midnapore, and Orissa.—Laterite of Orissa.—Fossil Teeth of *Ceratodus*.
- VOL. II. Royal 8vo, pp. 341, 1859. Pt. 1 (*out of print*): Report on the Vindhyan Rocks and their Associates in Bundelkand. Pt. 2 (*out of print*): Geological Structure of the Central Portion of the Nerbudda District.—Tertiary and Alluvial deposits of the Nerbudda Valley.—Geological Relations and probable Geological Age of the several Groups of Rocks in Central India and Bengal.
- VOL. III. Royal 8vo, pp. 438. Pt. 1, 1863 (*out of print*): Report on the Raniganj Coal-field.—Additional Remarks on the Geological Age of Indian Rock systems. Pt. 2, 1864 (*out of print*): On the Sub-Himalayan Ranges between the Ganges and Sutlej.
- VOL. IV. Royal 8vo, pp. 450. Pt. 1, 1863 (*price 2 Rs.*): Report on the Cretaceous Rocks of Trichinopoly District, Madras. Pt. 2, 1864 (*price 2 Rs.*): On the Structure of the Districts of Trichinopoly, Salem, &c. Pt. 3, 1865 (*price 1 Re.*): On the Coal of Assam, &c.
- VOL. V. Royal 8vo, pp. 354. Pt. 1, 1865 (*price 3 Rs.*): Sections across N. W. Himalaya, from Sutlej to Indus.—On the Gypsum of Spiti. Pt. 2, 1866 (*price 1 Re.*): On the geology of Bombay. Pt. 3, 1866 (*price 1 Re.*): On the Jherria Coal-field.—Geological Observations on Western Tibet.
- VOL. VI. Royal 8vo, pp. 395. Pt. 1, 1867 (*price 8 As.*): On the Neighbourhood of Lynyan, &c., in Sind.—Geology of a Portion of Cutch. Pt. 2, 1867 (*price 2 Rs.*): Bokáro Coal-field.—Rámgarh Coal-field.—Traps of Western and Central India. Pt. 3, 1869 (*price 2 Rs. 8 As.*): Taptee and Nerbudda Valleys.—Frog-beds in Bombay.—*Oxyglossus pusillus*.
- VOL. VII. Royal 8vo, pp. 342. Pt. 1, 1869 (*price 3 Rs.*): Vindhyan Series.—Mineral Statistics—Coal.—Shillong Plateau. Pt. 2, 1870 (*price 1 Re.*): Karihárbári Coal-field.—Deoghar Coal-field. Pt. 3, 1871 (*price 1 Re.*): Aden Water-supply.—Káranpura Coal-fields.
- VOL. VIII. Royal 8vo, pp. 353. Pt. 1, 1872 (*price 4 Rs.*): On the Kadapah and Karnul Formations in the Madras Presidency. Pt. 2, 1872 (*price 1 Re.*): Itkhuri Coal-field.—Daltongunj Coal-field.—Chope Coal-field.
- VOL. IX. Royal 8vo, pp. iv, 358. Pt. 1, 1872 (*price 4 Rs.*): Geology of Kutch. Pt. 2, 1872 (*price 1 Re.*): Geology of Nagpur.—Geology of Sirban Hill.—Carboniferous Ammonites, pp. 65.
- VOL. X. Royal 8vo, pp. 359. Pt. 1, 1873 (*price 3 Rs.*): Geology of Madras.—Sátpura Coal-basin. Pt. 2, 1874 (*price 2 Rs.*): Geology of Pegu.
- VOL. XI. Royal 8vo, pp. 338. Pt. 1, 1874 (*price 2 Rs.*): Geology of Dárjiling and Western Dúars. Pt. 2, 1876 (*price 3 Rs.*): Salt-region of Kohát, Trans-Indus, pp. 230.
- VOL. XII. Royal 8vo, pp. 363. Pt. 1, 1877 (*price 3 Rs.*): South Mahrátta Country. Pt. 2, 1876 (*price 2 Rs.*): Coal-fields of the Nága Hills, pp. 95.
- VOL. XIII. Royal 8vo, pp. 248. Pt. 1, 1877 (*price 2 Rs. 8 As.*): Wardha Valley Coal-field. Pt. 2, 1877 (*price 2 Rs. 8 As.*): Geology of the Rájmahál Hills.
- VOL. XIV. Royal 8vo, pp. 313, 1878. Geology of the Salt-range in the Punjab.
- VOL. XV. Royal 8vo, pp. 192. Pt. 1, 1878 (*price 2 Rs. 8 As.*): Geology of the Aurunga and Hutár Coal-fields (Palamow). Pt. 2, 1880 (*price 2 Rs. 8 As.*): Ramkola and Tatapani Coal-fields (Sirguja).
- VOL. XVI. Royal 8vo, pp. 264. Pt. 1, 1879 (*price 1 Re. 8 As.*): Geology of Eastern Coast from Lat. 15° to Masulipatam. Pt. 2, 1880 (*price 1 Re. 8 As.*): The Gneiss and Transition Rocks, and other Formations of the Nellore Portion of the Carnatic. Pt. 3, 1880 (*price 2 Rs.*): Coastal region of the Godáviri District.
- VOL. XVII. Royal 8vo, pp. 305. Pt. 1, 1879 (*price 3 Rs.*): Geology of Western Sind. Pt. 2, 1880 (*price 2 Rs.*): Trans-Indus extension of the Punjab Salt-range.
- VOL. XVIII. Royal 8vo, pp. 300. Pt. 1, 1881 (*price 2 Rs.*): Southern Afghanistan. Pt. 2, 1881 (*price 1 Re. 8 As.*): Mámbhúm and Singhbhúm. Pt. 3, 1881 (*price 2 Rs.*): Pranbíta Godáviri Valley.
- VOL. XIX. Royal 8vo, pp. 242. Pt. 1, 1882 (*price 2 Rs.*): The Cachar Earthquake of 1869. Pt. 2, 1882 (*price 1 Re.*): Thermal springs of India. Pt. 3, 1883 (*price 1 Re.*): Catalogue of Indian Earthquakes. Pt. 4, 1883 (*price 1 Re.*): Geology of parts of Manipur and the Naga Hills.
- VOL. XX. Royal 8vo, pp. 240, Pt. 1, 1883 (*price Rs. 2-8*): Geology of Madura and Tinnevely. Pt. 2, 1883 (*price Rs. 2-8*): Geological Notes on the Hills in the neighbourhood of the Sind and Punjab Frontier between Quetta and Dera Ghazi Khan.
- VOL. XXI. Royal 8vo, pp. 286. Pt. 1, 1884 (*price Rs. 2*): Geology of the Lower Narbada Valley. Pt. 2, 1884 (*price Re. 1*): Geology of Kathiawar. Pt. 3, 1885 (*price Rs. 2*): Coal-field of South Rewah. Pt. 4, 1885 (*price Re. 1*): Barren Island.
- VOL. XXII. Royal 8vo, pp. 344, 1883. The Geology of Kashmir, Chamba, and Khagán.
- VOL. XXIII. In preparation.
- VOL. XXIV. Pt. 1, 1887. The Chhindwara Coal-fields, (*price 1 Re. 8 As.*).

The price fixed for these publications is 5 Rs. (10s.) each volume.

Manual of the Geology of India, 2 Vols. and Map, 1879, (*out of print*). Vol. III (Economic Geology), 1881, *price 5 Rs. (10s.)* Vol. IV (Minerology), 1887, *price 2 Rs.*

To be had at the Geological Survey Office, Indian Museum, Calcutta, or through any Bookseller. London: Trübner & Co.

## RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

VOLS. I TO XIX, 1868 TO 1886.

THE RECORDS of the Geological Survey are issued quarterly,—in February, May, August, and November. They contain brief reports and papers; abstracts of more detailed work; notices of recent discoveries; donations to Museum, and additions to Library, &c. They are of the same size as the 'Memoirs,' but are separately pagged. Begun in June 1868.

The annual subscription for four numbers or parts is 2 Rs. (4s.). Postage additional; if for India, 4 As., for Great Britain, 8 As. (1s.).

CALCUTTA, September 7, 1887.

# PALÆONTOLOGIA INDICA.

(SERIES I, III, V, VI, VIII.)

CRETACEOUS FAUNA OF SOUTHERN INDIA, *by* F. STOLICZKA, *except* Vol. I, Pt. I, *by* H. F. BLANFORD.

- VOL. I. The Cephalopoda (1861-65), pp. 216, pls. 94 (6 double).  
" II. The Gastropoda (1867-68), pp. xiii, 500, pls. 28 (10 parts).  
" III. The Pelecypoda (1870-71), pp. xxii, 537, pls. 50 (13 parts).  
" IV. The Brachiopoda, Echinodermata, Corals, &c. (1872-73), pp. v, 202, pls. 29.

(SERIES II, XI, XII.)

THE FOSSIL FLORA OF THE GONDWANA SYSTEM, *by* O. FEISTMANTEL, *except* Vol. I, Pt. I, *by* T. OLDHAM AND J. MORRIS.

- VOL. I, pp. xvii, 233, pls. 72. 1863-79. Pt. 1: Rājmahāl Group, Rājmahāl Hills. Pt. 2: *Same, continued.* Pt. 3: Plants from Golapilli. Pt. 4: Outliers on the Madras Coast.  
" II, pp. xli, 115, pls. 26. 1876-78. Pt. 1: Jurassic Flora of Kach. Pt. 2: Flora of the Jabalpur Group.  
" III, pp. xi, 64 + 149, pls. 80 (9 double), (I-XXXI + I A-XLVII A: 1879-81. Pt. 1: The Flora of the Talchir-Karharbāri beds. Pt. 2: (Suppl.). Pt. 2: The Flora of the Damuda and Panchet Divisions. Pt. 3: The same (*concluded*).  
" IV, pp. xxvi, 52 + 71, pls. 35 (2 double), I-XXI + I A-XIV A). 1882-86 Pt. 1: The Flora of the South Rewah Gondwana basin. Pt. 2: The Flora of some of the Coal-fields in Western Bengal.

(SERIES IX.)

JURASSIC FAUNA OF KACH.

- VOL. I, pp. i, 247, pls. 60 (6 double). (1873-76). The Cephalopoda, *by* W. WAAGEN.

(SERIES IV.)

INDIAN PRETERTIARY VERTEBRATA.

- VOL. I, pp. vi, 137, pls. 26. 1865-1885. Pt. 1 (1865): The Vertebrate Fossils from the Panchet Rocks, *by* T. H. HUXLEY.—Pt. 2 (1878): The Vertebrate Fossils of the Kota-Maleri Group, *by* SIR P. DE M. GREY EGERTON and L. C. MIALL. Pt. 3 (1879): Reptilia and Batrachia, *by* R. LYDEKKER. Pt. 4 (1885): The Labyrinthodont from the Bijori Group, *by* R. LYDEKKER. Pt. 5 (1885): The Reptilia and Amphibia of the Maleri and Denwa groups, *by* R. LYDEKKER.

(SERIES X.)

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA *by* R. LYDEKKER, *except* Vol. I, Pt. I, *by* R. B. FOOTE.

- VOL. I, pp. xxx, 300, pls. 50. 1874-80. Pt. 1: Rhinoceros deccanensis. Pt. 2: Molar teeth and other remains of Mammalia. Pt. 3: Crania of Ruminants. Pt. 4: Supplement to pt. 3. Pt. 5: Siwalik and Narbada Proboscidea.  
" II, pp. xv, 363, pls. 45. 1881-84. Pt. 1: Siwalik Rhinocerotidae. Pt. 2: Supplement to Siwalik and Narbada Proboscidea. Pt. 3: Siwalik and Narbada Equidae. Pt. 4: Siwalik Camelopardalidae. Pt. 5: Siwalik Selenodont Suina. Pt. 6: Siwalik and Narbada Carnivora.  
" III, pp. xxiv, 264, pls. 37 (1884-86). Pt. 1: additional Siwalik Perissodactyla and Proboscidea. Pt. 2: Siwalik and Narbada Bunodont Suina. Pt. 3: Rodents and new Ruminants from the Siwaliks. Pt. 4: Siwalik Birds. Pt. 5: Mastodon teeth from Perim Island. Pt. 6: Siwalik and Narbada Chelonia. Pt. 7: Siwalik Crocodilia, Lacertilia and Ophidia. Pt. 8: Tertiary Fishes.  
" IV, Pt. 1 (1886). Siwalik Mammalia (Supplement 1), pp. 18, pls. 6. Pt. 2: (1886). The Fauna of the Karnul caves: (and addendum to pt. 1); pp. 40 (19-58), pls. 5 (vii-xi). Pt. 3: (1887). Eocene Chelonia from the Salt Range: pp. 8 (59-66), pls. 2 (xii-xiii).

(SERIES VII, XIV.)

TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA.

- VOL. I, pp. 16 + 110 + 382 + 91, pls. 5 + 28 + 58 + 13. Pt. 1 (1871): Tertiary Crabs from Sind and Kach, *by* F. STOLICZKA. Pt. 1 (new 2) (1880): Sind Fossil Corals and Alcyonaria, *by* P. MARTIN DUNCAN. Pt. 3 (1882-86): The Fossil Echinoidea of Sind, *by* P. MARTIN DUNCAN and W. PERCY SLADEN. *Fas. 1*: The *Curdita beaumonti* beds. *Fas. 2*: The Ranikot series in Western Sind. *Fas. 3*: The Kirthar Series. *Fas. 4*: The Nari Series (oligocene). *Fas. 5*: The Gaj Series (miocene). *Fas. 6*: The Makrán Series (pliocene). Pt. 4 (1883): The Fossil Echinoidea of Kachh and Kattywar, *by* P. MARTIN DUNCAN and W. PERCY SLADEN.

(SERIES XIII.)

SALT-RANGE FOSSILS, *by* WILLIAM WAAGEN, PH.D.

- Productus-Limestone Group: 1 (1879). Pisces, Cephalopoda, pp. 72, pls. 6.  
" 2 (1880). Gasteropoda and supplement to pt. 1, pp. 111 (73-183), pls. 10 (vii-xvi); (1 double).  
" 3 (1881). Pelecypoda, pp. 144 (185-328), pls. 8 (xvii-xxiv).  
" 4 (1882-85). Brachiopoda, pp. 442 (329-770), pls. 62 (xxv-lxxxvi).  
" 5 (1885). Bryozoa—Annelida—Echinodermata, pp. 64 (771-834), pls. 10 (lxxxvii-xcvi).  
" 6 (1886). Cœlenterata, pp. 90 (835-924), pls. 20 (xcvii-cxvi).  
" 7 (1887). Cœlenterata, Protozoa, pp. 70 (925-994), pls. 12 (cxvii-cxxviii).

The price fixed for these publications is 4 annas (6 pence) per single plate.

To be had at the Geological Survey Office, Indian Museum, Calcutta, or through any Bookseller. London: Trübner & Co.

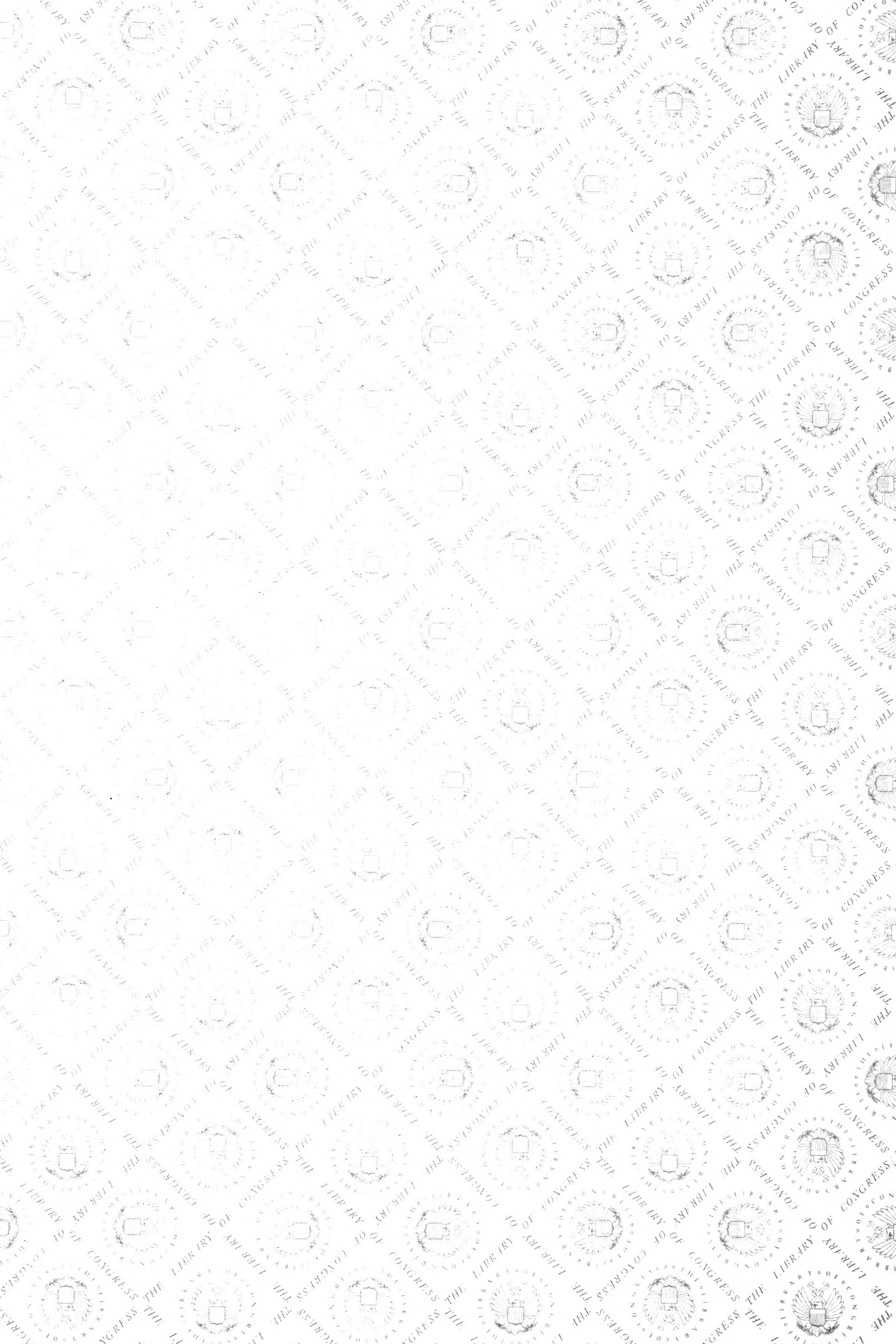












LIBRARY OF CONGRESS



0 005 022 530 6